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Removal Action Work Plan
Terminal 1 South
Portland, Oregon

Prepared for
Port of Portland
Project/Task No. 24232/820

March 26, 2002
15230-01

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Prepared by
Hart Crowser, Inc.

For

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TERMINAL 1 SOUTH
PORTLAND, OREGON

1.0 INTRODUCTION

This Work Plan presents the scope of work and schedule for completing the Removal Action (RA) for the Port of Portland (Port) at Terminal 1 South Site (T1S Site) in Portland, Oregon. The primary purpose of the RA is to reduce threats to human health from soil contaminated with polynuclear aromatic hydrocarbons (PAHs) and metals (specifically arsenic and lead). A secondary purpose of the RA is to remove and dispose of soil with total petroleum hydrocarbons (TPH) that will be excavated to reduce risk to support future site use. This Work Plan was prepared for the Port under Project/Task No. 24232/820. The planned removal action will consist of the following tasks:

- Install temporary shoring to provide stability to the adjacent Front Avenue during excavation activities;
- Excavate contaminated soil exceeding the cleanup or hot spot levels, or contaminated soil targeted to reduce risk to support future site use;
- Dispose of the contaminated soil in an appropriate licensed waste disposal/treatment facility;
- Backfill excavation areas with on-site soils sufficiently to maintain stable temporary slopes without the need for shoring;
- Implement site security measures; and
- Prepare a report discussing the remedial action.

These activities are discussed in further detail within this Work Plan.

2.0 SITE BACKGROUND

This section summarizes the available information on this site. A more detailed description of environmental activities and the results of the remedial investigation (RI) conducted at this site are provided in the Terminal 1 South Remedial Investigation Report (Hahn and Associates, 2001a) and the Monitoring Well Installation and Groundwater Sampling Report (Hahn and Associates, 2001b).

2.1 Site Location and Description

Site Location. The T1S Site is located at 2100 NW Front Avenue along the Willamette River in Portland, Oregon (Figure 1). The site consists of approximately 21 acres located northwest of Interstate 405 (Fremont Bridge), northeast of NW Front Avenue, southeast of Slip No. 2, and southwest of the Willamette River (Figures 1 and 2). The T1S Site does not include sediments adjacent to the Site.

Site Description. Two primary structures, designated as Warehouse No. 2 and House No. 104, are currently located at the T1S Site. Tristar Transload currently leases and operates the open storage area southeast of Slip No. 2 and northwest of House No. 104 and portions of House No. 104. The remaining portions of the site are unoccupied. Additionally, an extensive dock structure is present over submerged land at Berths 104, 105, and 106.

The topography at the T1S Site is generally level at an elevation of approximately 30 feet above mean sea level (msl). The site is generally paved with asphalt or concrete with no vegetation or little bare ground present.

Site History. Historically, Terminal 1 has been used for the staging of lumber, logs, paper products, steel containers, and bagged grain. Various companies have owned or leased portions of the Terminal 1 South Complex (see RI Report; Hahn and Associates, 2001a).

2.2 Previous Site Investigations and Work

Site Geology and Hydrogeology. The subsurface soils encountered during previous investigations were predominantly sands and silts with occasional gravel to the maximum depth of investigation at 80 feet below the ground surface (bgs). Groundwater in the vicinity of the T1S Site generally occurs in three principal hydrogeologic zones: (1) a shallow unconfined fill/alluvial deposit (shallow water-bearing zone [WBZ]); (2) generally confined Troutdale WBZ; and (3) the confined Columbia River Basalt WBZ. Unconfined groundwater was encountered within the shallow WBZ (fill) at an average depth of approximately 23 feet bgs. Groundwater elevation measured in the seven monitoring wells installed at the T1S Site indicate a general flow to the northeast towards the Willamette River with a decline or even reversal of the gradient near the river (Hahn and Associates, 2001b).

Previous Investigations. Sampling events were conducted in 1998, 2000, and 2001. A total of 112 push probe borings were installed for the collection of soil and groundwater samples during these site investigations. The locations of these push probes are presented on Figure 2. Please refer to the RI Report (Hahn and Associates, 2001a) for further discussion of these activities and results.

A groundwater investigation was conducted at the T1S Site in August, September, and October 2001 (Hahn and Associates, 2001b). Site activities included installation, development, and sampling of seven groundwater monitoring wells at the site. The locations of the groundwater monitoring wells are presented on Figure 2. Please refer to the groundwater sampling report for further discussion of these activities and results (Hahn and Associates, 2001b).

Environmental investigations conducted at the site identified T1S Site soils and groundwater concentrations exceeding screening levels. Likely or potential sources of contamination included underground storage tanks and dry wells. Petroleum hydrocarbons and metals were identified as contaminants of interest.

Land Use. The approximate 21-acre T1S Site has historically been zoned as "IH" for Heavy Industrial. Surrounding adjacent properties are zoned "IH" Heavy Industrial and "EX" Central Employment. The site is currently zoned as Central Residential (RX) such that it can be redeveloped for an alternative use. The RX zoning is considered the comprehensive plan for the property. Based on the RX zoning designation, it is expected the site will be used for mixed-use residential/commercial development in the future.

Groundwater Use. A beneficial groundwater use evaluation was conducted for the Hoyt Street Property (RETEC, 1997) that adjoins the southeast corner of the T1S Site. Hahn and Associates conducted an additional well inventory as part of the RI and the groundwater monitoring study to supplement the RETEC survey. Based on trends in groundwater use in the area, as well as RETEC fate and transport modeling, the only identified beneficial use for groundwater is discharge to the Willamette River. No water wells were found to be in use within 1/2 half mile of the T1S Site. No surface water rights were identified within 1/2 mile of the T1S Site.

2.3 Human Health and Ecological Risk Assessment

Human Health Risk Assessment. Hart Crowser conducted a human health risk assessment (HHRA) for the T1S Site (Hart Crowser 2002a). Potential exposed populations evaluated in the HHRA include future residents, current and future commercial workers, and future utility/excavation workers. The site was divided into three Areas of Concern (AOCs), and separate risk calculations and risk estimates were conducted for each area. AOCs A, B, and C are presented on Figure 2. In summary, the risk assessment identified unacceptable risk to human receptors as follows:

Area A

- Future resident or commercial worker dermal contact or ingestion of soil with PAHs, lead, and arsenic; and
- Excavation worker dermal contact or ingestion of soil with lead.

Area B

- Future resident dermal contact or ingestion of soil with benzo(a)pyrene.

Area C

- No unacceptable risk.

Ecological Risk Assessment Results. The Level 1 Scoping Ecological Risk Assessment (ERA) did not identify any ecologically important species or habitats at the T1S Site. The site is almost entirely paved or covered by buildings. The absence of upland habitat indicates there are no complete exposure pathways for terrestrial ecological receptors to come in contact with contaminated soil at the T1S Site.

A Modified Level 2 Screening ERA was conducted on the available groundwater monitoring well data collected at this site. There were no detected concentrations of organic constituents in the seven groundwater monitoring wells that exceeded their corresponding Ecological Screening Benchmark Values (SBVs). There were two metals (copper and lead) detected in groundwater that exceeded SBVs based on the analysis of unfiltered, total metals, but when the same samples were analyzed for dissolved metals, copper and lead were not detected. The dissolved fraction of metals represents the bioavailable fraction in aqueous environmental media. Therefore, it is concluded that there is no potential for adverse ecological impacts to aquatic ecological receptors from the discharge of groundwater to the Willamette River. No additional ecological risk assessment activities are warranted at this site.

2.4 Feasibility Study

Feasibility Study. A feasibility study was completed for the T1S Site (Hart Crowser, 2002b), and it was determined that excavation of the soil exceeding established cleanup levels and the off-site treatment/disposal of the excavated soil is the best alternative for the remedial action. Remedial action levels were established based on the HHRA (corresponding to the residential RBC [1×10^{-6} for individual carcinogens or hazard index of 1 for noncarcinogens]) and the statistical background concentration for arsenic (Hahn and Associates, 2001a). Hot spot levels were calculated based on 100 times (carcinogens) or 10 times (noncarcinogens) the established cleanup level.

Table 1 lists the cleanup levels with the corresponding hot spot levels. Figure 3 shows the samples locations and identifies the areas exceeding the residential risk based concentration (RBC) (lead and PAHs) or the statistical background concentration for arsenic. Hot spots were identified at B-68 (lead and benzo[a]pyrene) and at B-92 (benzo[a]pyrene).

3.0 OBJECTIVES AND RATIONALE

The objectives of the removal action are:

- Remove soil exceeding cleanup or hot spot levels; and
- Remove contaminated soil to reduce risk to support future site use.

Removal Action Cleanup Objective. The cleanup levels established in the feasibility study are the removal action cleanup objectives. These are the residential RBCs for benzo(a)pyrene, benzo(a)anthracene, dibenz(a,h)anthracene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and lead and the statistical background concentration for arsenic. The risk-based cleanup levels are presented in Table 1.

Soil Exceeding Cleanup Levels. Figure 3 shows the lateral extent of soil exceeding the cleanup levels. Areas and volumes of soil exceeding cleanup levels are included in the areas/volumes discussed in Section 4.3.

Future Site Development. Figure 4 shows the lateral extent of soil requiring removal as part of future site development plans. The areas and volumes of soil requiring removal as part of the future site development are included in the areas/volumes discussed in Section 4.3.

Waste Designation. Based on the site history and chemical analysis results, Hart Crowser completed a preliminary waste designation for the soil that will be excavated from the T1S Site. Waste generated from the site may be designated in one of two manners, as discussed below.

- Hazardous Waste – Lead and mercury concentrations (i.e., total metals) at sample locations B-38 (A-2) and B-68 (A-3) are above typical concentrations needed for possible failure of the Toxicity Characteristic Leaching Procedure (TCLP). Soil excavated from these areas will be temporarily stockpiled and sampled for chemical analyses (TCLP). Analytical results will determine final waste designation.

- Non-hazardous Waste – Non-hazardous soil excavated from other areas will be transported to a licensed Subtitle D waste landfill for disposition, or an off-site treatment facility for thermal treatment.

4.0 SOIL REMOVAL ACTION

This section describes the planned removal action. The removal action will consist of site preparation activities, shoring, excavation of contaminated soil exceeding the removal action objectives, backfilling, and site security measures.

4.1 Site Preparation

In preparation for the removal, several actions must be performed prior to the excavation activities. These activities are discussed below.

Site Access. The Port will arrange access to the T1S Site for Hart Crowser and the contractor.

Health and Safety Plan. A Health and Safety Plan (HSP) will be developed by the contractor prior to performing any on-site activities. The HSP will be prepared in accordance with Occupational Safety and Health Act (OSHA) and Oregon Administrative Rules (OARs). Hart Crowser's HSP covering Hart Crowser employees for sampling activities and construction oversight is included in Appendix B.

Underground Utilities. The contractor will be responsible for having underground utilities located and marked prior to removal action activities. They will contact the Oregon Utility Notification Center who will in turn notify the various utilities in the area to mark any underground installations. In addition, the Port utility locator will be notified. The contractor shall be responsible for maintaining water supply to Warehouse No. 2 and House No. 104 during the work. Utilities shall be restored upon completion of the work.

Permit Acquisition. It is our understanding that the City of Portland requires a permit to complete shoring, excavation, and backfill work. In addition, work adjacent to city streets may require review by the City transportation office. The Port will obtain applicable permits from the City of Portland.

Site Security and Temporary Fencing. The removal contractor is responsible for site security. Access to the site is provided through Front Avenue, as shown on Figure 3. Access to the site must be limited to authorized personnel (i.e., contractor, Hart Crowser, and Port of Portland). As such, barricades, caution tape, and/or warning signs must be posted appropriately to limit site access. The contractor shall provide workers to direct traffic on public roads, if needed (conforming to all state or local requirements for traffic control). A temporary office trailer is not required. Temporary sanitary facilities (including a toilet and hand washing facility) must be provided by the contractor throughout the duration of the site work.

Erosion and Dust Control. Depending upon the weather conditions, dust is possible. The contractor is responsible for maintaining a condition of no visible dust in the work area. This may be achieved by application of water.

During the course of the work, the contractor shall conduct the removal to minimize the amount of equipment traffic entering/leaving the area of contamination. For example, trucks or drop boxes shall be staged adjacent to the area of contamination. Excavators/loaders within the area of contamination shall then load the trucks or drop boxes without leaving the area of contamination. At a minimum, all equipment leaving the area of contamination shall be decontaminated by dry brushing to remove all loose soil. The contractor shall be responsible for any additional equipment washing needed to meet federal, state, or local requirements for sediment/runoff control. The contractor shall promptly clean the adjacent road surfaces of any tracked soil.

Well Abandonment and Protection. The contractor shall be responsible for abandonment of monitoring well MW-1 in accordance with Water Resource Department requirements. Well MW-4 shall be protected from damage and restored as necessary during backfilling.

Removal of Railroad Tracks. The contractor shall be responsible for the removal of the railroad tracks and ties in excavation areas 10, 17, 18, and 19. Removal of railroad tracks and ties will be completed only as necessary to facilitate the removal of soil. The railroad tracks shall be stacked on site in a location designated by the Port. Ties shall be recycled or disposed of at a permitted facility (as appropriate based on condition).

Fixed Reference Points. Prior to the work, Hart Crowser and/or the Port of Portland may establish several reference points for measuring the excavation limits. The contractor will be responsible for maintaining these reference points during the work.

Protection of Existing Structures. The removal contractor shall be responsible for the protection of all existing structures in the vicinity of the removal action, including but not limited to adjacent buildings, roadways, sidewalks, and groundwater monitoring wells (i.e., groundwater monitoring well MW-4). Except for demolition specifically required (and approved by the Port) to achieve the limits of excavation (e.g., concrete floor in area 22), structures damaged during the excavation work will be the responsibility of the contractor to repair.

4.2 Shoring and Bracing

Temporary shoring and bracing may be constructed to provide stability to Front Avenue (Area 6), House No. 104 (Areas 16 and 17), or Warehouse No. 2 (Area 18). The structural shoring will provide lateral support of soils and limit lateral movement of soils supporting structures, roadways, etc. Bracing would support structures during adjacent excavation. Shoring or bracing design will be completed during final design.

4.3 Excavation and Hauling

An estimated 28,920 cubic yards of soil will be excavated for off-site disposal at an appropriate licensed disposal/treatment facility or facilities. The contractor will provide all earthwork and hauling required to complete the work. The contractor will procure a DEQ permitted disposal/treatment facility. Hart Crowser will provide chemical data needed for waste profiling and facility approval. Hart Crowser will document the activities with field notes and photographs.

Excavation Limits. Based on the results of the assessment activities, the proposed extent of excavations for the removal action are shown on Figure 5 and summarized in Table 2. Excavation depths are not expected to vary from the depths listed in Table 2. The lateral extent of excavations shall be determined as follows:

- Excavations 5, 6, 13, 14, 15, and 18 shall not extend beyond the property line.
- Excavations 16, 17, 18, and 19 shall not extend beneath adjacent buildings (House No. 104 or Warehouse No. 2).
- Excavations 2, 8, 17, and 20 shall continue until sidewall confirmation results meet risk-based cleanup levels for PAHs. The contractor shall allow two days for receipt of analytical results.
- All other excavation limits or portions thereof not limited as described above shall be determined based on TPH concentrations (subject to the sale agreement and amendments). The contractor shall allow two days for receipt of analytical results.

In general, estimated removal areas and volumes are:

Total:

Area - 87,400 square feet (not including potential hazardous waste)
Volume - 28,600 cubic yards (not including potential hazardous waste)

Potential Hazardous Waste Total:

Area - 1,420 square feet
Volume - 350 cubic yards

Overburden Clean Soil Total:

Area - 22,900 square feet
Volume - 4,230 cubic yards

Excavation Methodology and Sequencing of Work. The extent of the excavations will be staked by Hart Crowser. The removal will be conducted using standard earthmoving equipment. Method and means shall be determined by the contractor. Contaminated soil excavated at sample locations B-38 (3) and B-68 (7) may require disposal as a hazardous waste and will be temporarily stockpiled pending receipt of chemical analysis (i.e., TCLP).

Asphalt/Concrete Removal. A majority of the excavation areas are paved with asphalt or concrete with no vegetation or little bare ground present. The asphalt and concrete surfacing the site will be removed prior to soil excavation. Asphalt and concrete material may not be used in backfilling procedures. Asphalt and concrete shall be recycled or disposed of at a permitted facility.

Air Monitoring. The contractor shall be responsible for any air monitoring required by the health and safety plan. Appropriate personal protection equipment (PPE) for on-site workers may be required (i.e., respirators) based on the measurements.

Stockpiling. Contaminated soil (from 3 and 7) may be only stockpiled temporarily near the excavation area pending receipt of chemical analysis (i.e., TCLP). Contaminated soil will be placed on 6-mil plastic and covered during times of inactivity. Stockpiles shall be managed in such a manner as to prevent dust generation.

Hauling. The contractor shall load the excavated soil into trucks or drop boxes for transportation to the disposal site. The contractor shall be responsible for providing the trucks and will be responsible for the soil until it is accepted at the landfill or treatment facility. Prior to departure from the site, all loose soil shall be brushed from the truck or box and collected. The load shall be covered with a tarp during transport. Hart Crowser will provide assistance with manifests or other documentation required for transport of the soil.

Disposal. The excavated soil at locations 3 and 7 may be designated a hazardous waste and, if so, shall be disposed of in a licensed Subtitle C hazardous waste landfill. Soil excavated from all other areas will be disposed of as a non-hazardous waste in a licensed Subtitle D solid waste landfill or thermal treatment facility. It shall be the responsibility of the contractor to arrange for disposal of the excavated soil, but they must obtain approval from the Port prior to transport. Hart Crowser will provide assistance with documentation required to dispose of the soil.

IDW Disposal. There are currently 25 drums of soil that contain investigation derived waste (IDW) generated from previous site investigations. The excavation contractor will be responsible for the transportation and disposal of the drums of soil along with the excavated soil.

4.4 Backfilling

Backfilling shall commence only upon approval of Hart Crowser. In general, the limits of the excavation shall be determined by physical limitations or chemical concentrations, as discussed in Section 4.3.

Geotextile. Once the excavations have been completed, a minimum 4-ounce-per-square yard nonwoven geotextile fabric will be placed on the bottom and sidewalls of the excavation. The geotextile will serve as a demarcation layer between the existing soil and the backfill material. The edges of the fabric shall be overlapped a minimum of one foot to provide continuity.

Backfill. The contractor shall backfill the excavation areas only as needed to maintain stability using on-site soils conducive to support future site use. Excavated clean overburden soil from areas 4, 10, and 19 shall be used. If additional soil is required, the contractor shall use soil obtained on-site from the perimeter of completed excavations or imported soil from a commercial source. Backfilling procedures performed adjacent to shoring will be completed by backfilling to previously existing grade or by providing a 5-foot bench with accompanying side slopes (tapering away from the shoring as needed to maintain stability when shoring is removed, but not steeper than 2H:1V). A typical backfilling schematic in the vicinity of shoring is shown on Figure 6.

Compaction. Backfill shall be compacted by mechanical means using appropriate machines that are capable of compacting the material to the specified density. All material shall be moistened or aerated as necessary to provide the moisture content that readily facilitates obtaining the specified compaction. The contractor shall arrange for Modified Proctor (ASTM D-1557) moisture density testing.

Backfill is to be spread in 1-foot-thick lifts and compacted to 92 percent of maximum (ASTM D1557) from the bottom of the excavation to 2 feet from the ground surface. The backfill is to be spread in 6-inch-thick lifts and compacted to 92 percent of maximum in the upper 2 feet. The contractor shall be responsible for all testing to verify compaction, and Hart Crowser may conduct independent testing. Copies of the Proctor and compaction results will be provided to Hart Crowser.

4.5 Site Closure Activities

Site Security Measures. Upon completion of excavation and backfilling activities, the contractor shall secure the disturbed excavation areas (areas not backfilled to previously existing grade) with temporary fencing. The temporary fencing shall be constructed around the perimeter of the excavation area. Temporary fencing is not required if excavations are backfilled to existing grade.

Protecting Existing Markers. The contractor shall preserve existing markers or benchmarks that exist on the property.

Final Site Cleanup and Security. The contractor will remove all debris and garbage generated by this work from the site. Where possible, wastes should be recycled (e.g., drums). After completion of all other work, the contractor will remove any temporary facilities (except fencing needed to protect excavations not backfilled to existing grade).

5.0 SAMPLING AND ANALYSIS PLAN

The overall approach to the confirmation and waste designation sampling of excavated materials is presented in this section. Please refer to Appendix A for detailed discussion of field and quality assurance/quality control (QA/QC) procedures. A site specific Health and Safety Plan (HSP) for sampling activities is included in Appendix B.

5.1 Soil Sampling Collection for Chemical Analysis

Hart Crowser will collect soil samples for chemical analysis from the excavation floor/sidewalls after the excavation has been completed. Samples will also be collected from stockpiles generated from areas previously defined as potential for disposal as a hazardous waste. The purpose of the confirmation samples will be to verify cleanup levels have been attained, document the contaminant concentrations in soil remaining, and assist in risk-based calculations. Stockpile samples will be collected for purposes of waste designation.

Confirmation Soil Samples. Following removal of the contaminated soil identified during previous site characterizations, Hart Crowser will collect confirmation soil samples from the excavation floor and sidewalls to verify cleanup levels have been attained. Confirmation samples will be collected from the excavation perimeter (at a frequency of about every 100 feet of sidewall) and from the excavation floor (at a frequency of one sample per 2,500 square feet). We anticipate 40 samples will be collected from the excavation floor and sidewalls to provide representative coverage. Sample locations will be measured relative to site features (e.g., monitoring wells).

If the excavation is sloped so that it may be safely entered, discrete soil samples will be collected directly from the excavation floor. Otherwise, samples will be collected from the excavator bucket after obtaining a representative scoop from a location designated by Hart Crowser personnel.

Confirmation samples collected from hot spot areas (3 and 16) will be transported to the analytical laboratory and analyzed on a rapid turnaround basis (i.e., 48 hours). If concentrations exceed hot spot levels and physical restraints allow further excavation, additional soil will be excavated in those areas, and sampling and analysis will be repeated.

Confirmation samples collected from the remainder of the excavation (excluding hot spot confirmation samples) will be transported to the analytical laboratory and analyzed as follows:

- Samples collected from the floor of excavations or sidewalls adjacent to property lines or buildings will be analyzed on a standard turnaround; and
- All remaining samples will be analyzed on a rapid turnaround basis.

Stockpile Soil Samples. Stockpiles generated from areas (3 and 7) defined as potential hazardous waste will be sampled for waste designation purposes. One composite sample will be collected from each 200 cubic yards (or portion

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thereof) of soil within each stockpile. The samples will be transported to the analytical laboratory and analyzed on a rapid turnaround basis (i.e., 48 hours). Results from the analysis will be used for waste designation.

Collected soil samples (i.e., confirmation or stockpile samples) will be screened in the field for the presence of volatile organic compounds (VOCs) using a photoionization detector (PID) and for oil using a sheen test. Please refer to Appendix A for a more detailed discussion of field screening techniques and sampling procedures.

5.2 Chemical Analysis Program

North Creek Analytical of Beaverton, Oregon, will perform chemical analyses on the samples. A written report documenting analytical results and supporting QA/QC data will be prepared by North Creek Analytical and will be included as an attachment to the final report. Section 2 of Appendix A presents the analytical testing program for the project.

The overall analytical testing program will include the following analyses on selected samples (see Appendix A):

- Diesel and heavy oil range hydrocarbons using Northwest TPH-Dx;
- PAHs using EPA Method 8270-SIM;
- Total metals using EPA Method 6020/7471A (RCRA 8); and
- TCLP metals using EPA Method 1311/6010A series methods (RCRA 8).

5.3 Quality Assurance and Quality Control

The general objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to assess residual concentrations in the excavated area and determine waste designation. Data collected from this remedial action may be used in a residual risk assessment. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain of custody procedures.

Section 3 of Appendix A presents the project quality assurance plan. This plan includes QA objectives, sampling and custody procedures, quality assurance sampling analyses, data validation, and quality assurance reporting.

6.0 REPORTING

Hart Crowser will prepare reports to document the removal action. During the removal action, weekly progress reports will be prepared discussing the progress of site activities. After the conclusion of the removal action, we will prepare a Removal Action Summary Report summarizing the site activities. These reports are discussed in further detail below.

6.1 Weekly Progress Reports

During the removal, Hart Crowser will prepare weekly reports for delivery to the Port and DEQ. These reports will be approximately two pages in length and will include discussions regarding:

- On-site personnel;
- Activities completed, in-progress, and planned;
- Problems encountered; and
- Recommended solutions.

6.2 Final Removal Action Report

After the conclusion of field activities and upon receipt of all supporting documentation (i.e., weight tickets and permits), Hart Crowser will prepare the Final Removal Action Report for submission to the DEQ. The report will discuss all activities conducted on the site, the type and quantity of waste disposed, conditions of the site after completion of removal activities, problems and resolutions, and conclusions and recommendations, which discuss if the cleanup levels were met. An outline of the major topics to be discussed in the Final Removal Action Report are listed below:

1.0 Introduction
2.0 Site Description and Background
3.0 Previous Site Investigations
4.0 Removal Action Objectives
5.0 Description of Removal Activities
    5.1 Site Preparation Activities
    5.2 Shoring Implementation
    5.3 Soil Excavation
    5.4 Hauling and Disposal
6.0 Confirmation Sample Results
7.0 Conclusions

This report will include figures showing the extent of the excavation, photographs, and copies of supporting documentation (e.g., manifests, weight tickets).

7.0 SCHEDULE

It is anticipated that the work for this project will be completed in two phases. Phase I is scheduled for advertisement for bids in mid-April. Upon selection of a contractor, the construction schedule will be developed. Phase II is scheduled for construction in late summer 2002.

8.0 REFERENCES

Hahn and Associates, 2001a. Terminal 1 South Remedial Investigation Report. July 12, 2001 (Volumes 1 and 2).

Hahn and Associates, 2001b. Monitoring Well Installation and Groundwater Sampling Report. December 19, 2001.

Hart Crowser, 2002a. Human Health and Ecological Baseline Risk Assessment, Terminal 1 South. Portland, Oregon, January 18, 2002 (DRAFT).

Hart Crowser, 2002b. Feasibility Study, Terminal 1 South. Portland, Oregon, February 1, 2002.

Table 1 - Cleanup and Hot Spot Levels
Terminal 1 South Removal Action Work Plan
Portland, Oregon

Contaminant of Concern	Cleanup Level[1]	Hot Spot Level[2]
PAHs		
benzo(a)pyrene	0.021	2.1
benzo(a)anthracene	0.21	21
dibenz(a,h)anthracene	0.021	2.1
benzo(b)fluoranthene	0.21	21
indeno(1,2,3-cd)pyrene	0.21	21
Arsenic	5.33[3]	38[4]
Lead	400	4,000

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Notes:

(1) Based on Human Health Risk Assessment (Hart Crowser, 2002), except arsenic (see footnote 3).

(2) Calculated based on 100 times (carcinogens) or 10 times (noncarcinogens) the established Cleanup Level.

(3) Based on Statistical Background Concentration (Hahn and Associates, 2001).

(4) Calculated based on 100 times the acceptable risk level. Arsenic residential soil acceptable risk level is 0.38 mg/kg (Region 9 Preliminary Remediation Goals [EPA, 2000]).

Table 2 - Removal Areas and Volumes
Terminal 1 South Removal Action Work Plan
Portland, Oregon

Area[1]	Area (square feet)	Excavation Depth (feet)	Clean Overburden Depth (feet)	Clean Overburden Volume (cubic yards)	Contaminated Soil Volume (cubic yards)
1	1,949	5	--	--	361
2	355	3	--	--	39
3	710	3	--	--	79
4	11,474	15	5	2,125	4,250
5	2,742	5	--	--	508
6	18,150	15	--	--	10,083
7	710	10	--	--	263
8	804	3	--	--	89
9	798	5	--	--	148
10	7,150	15	5	1,324	2,648
11	3,309	15	--	--	1,838
12	10,770	3	--	--	1,197
13	4,379	5	--	--	811
14	9,015	10	--	--	3,339
15	1,897	5	--	--	351
16	4,200	3	--	--	467
17	2,878	10	--	--	1,066
18	4,235	10	5	784	784
19	1,358	5	--	--	251
20	216	3	--	--	24
21	1,704	5	--	--	316

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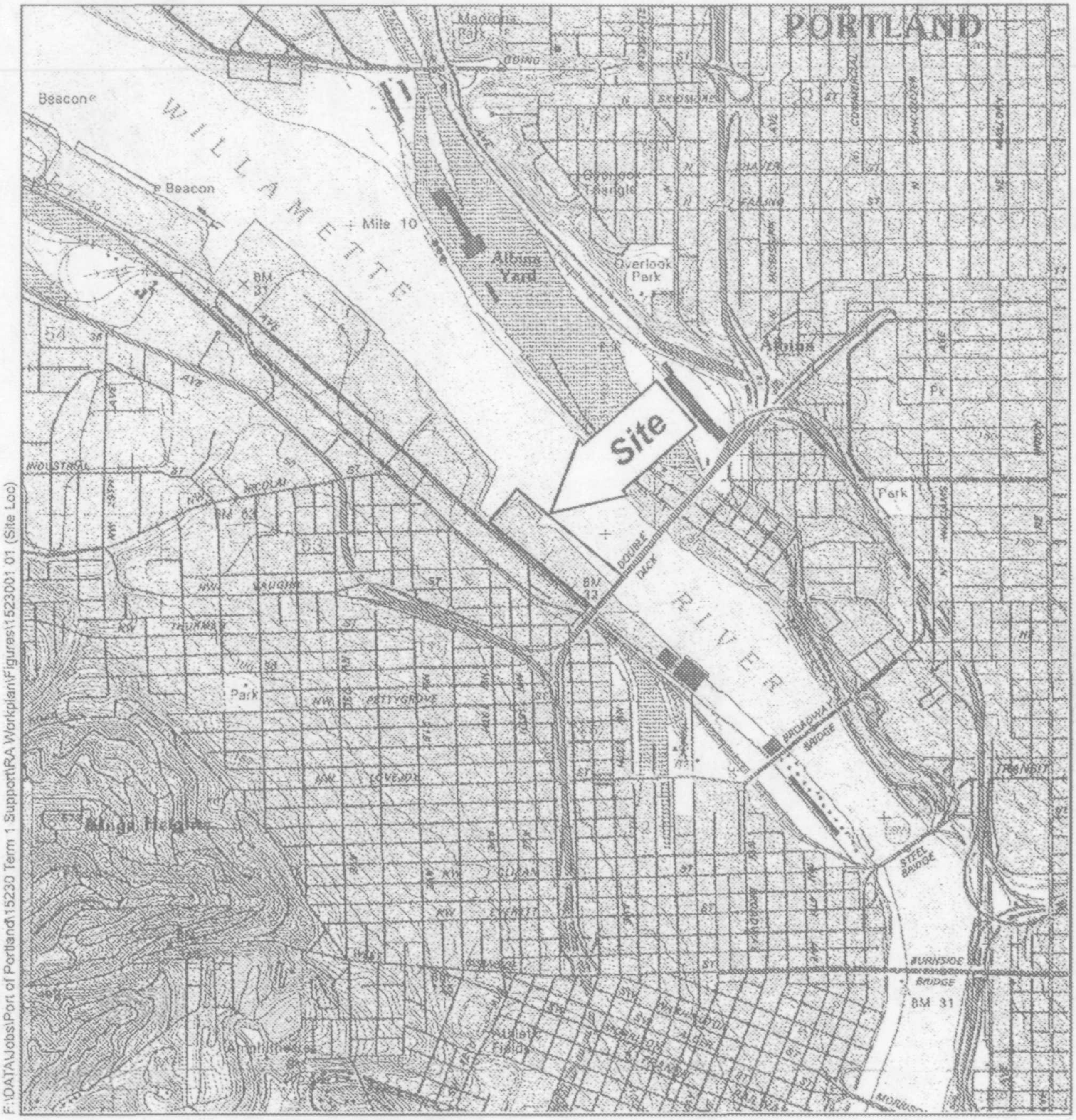
Total Estimated Hazardous Waste Volume	350	(490 tons)
Total Estimated Non-hazardous Waste Volume	28,570	(40,000 tons)
Total Estimated Clean Overburden Volume	4,230	(5,930 tons)

Notes:
1. Proposed Removal Areas - see Figure 5.
2. Shading denotes possible soil disposal as hazardous waste (waste designation based on TCLP analysis).

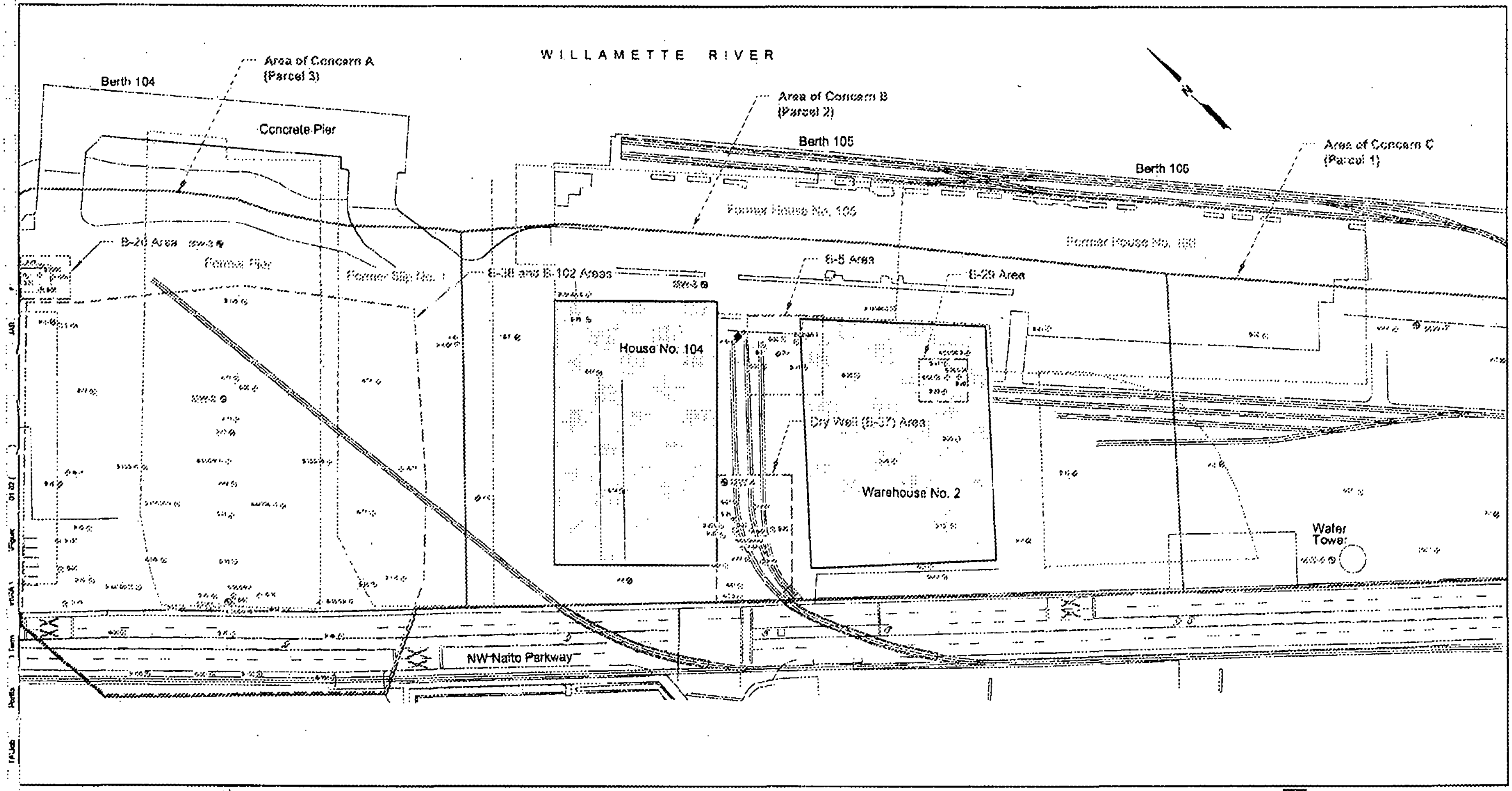
Site Location Map
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



Note: Base map prepared from the USGS 7.5-minute quadrangle of Portland, OR dated 1990.

HARTCROWSER
15230-01 3/02
Figure 1

Site Plan
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



Note: Base map prepared from an AutoCAD file provided by Olson Engineering, 8/27/01.

Legend:

Maul Foster and Alongi, Inc., Push Probe Boring Location and Number (March 1998)

HAI Monitoring Well Location and Number (2001)

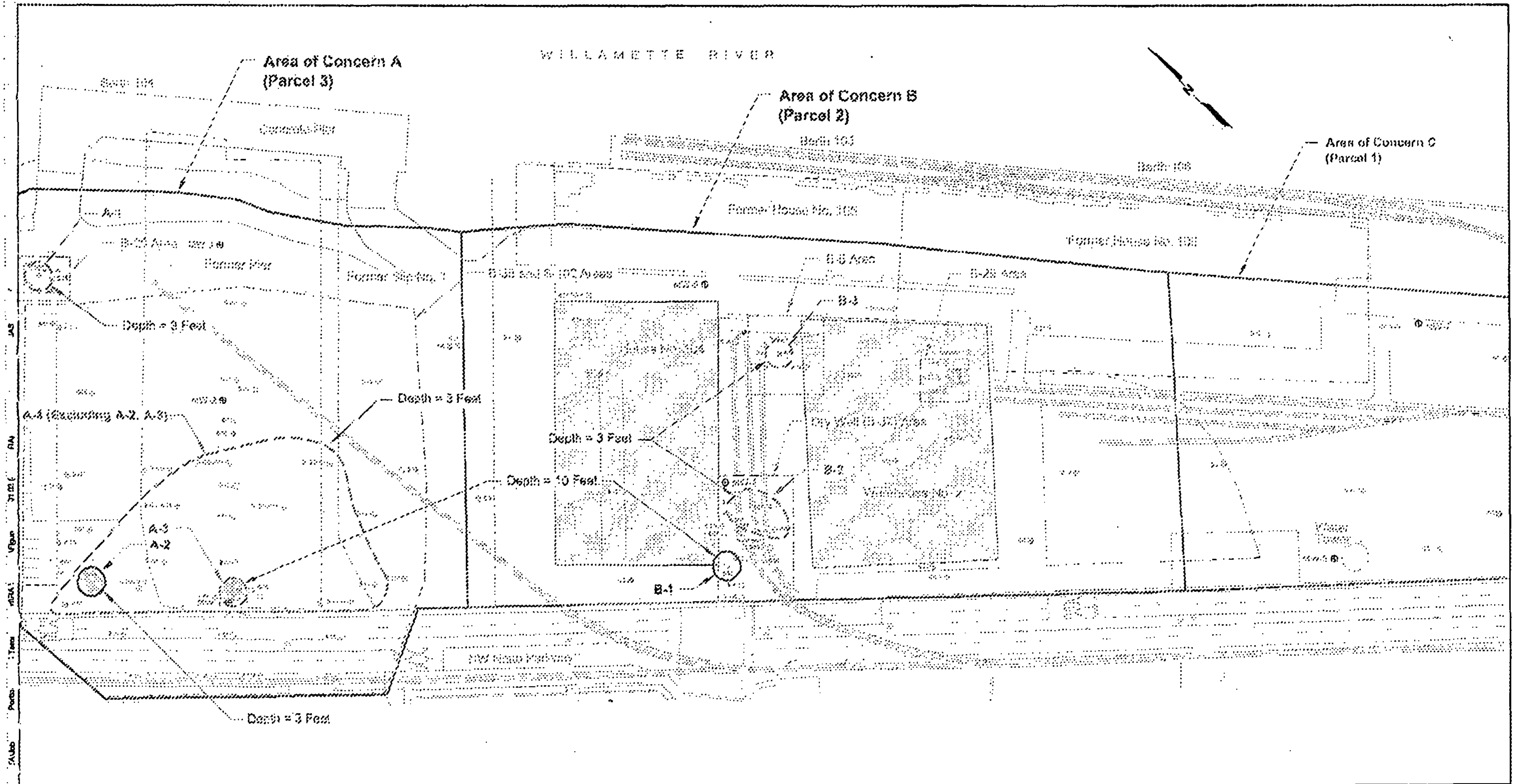
HAI Push Probe Boring Location and Number (2000)

0 100 200
Approximate Scale in Feet

HARTCROWSER
15230-01 *3/02*
Figure 2

POPT1S603660

Location of Soil Above Cleanup or Hot Spot Levels
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



Note: Base map prepared from an AutoCAD file provided by Olson Engineering, 8/27/01.

Legend:

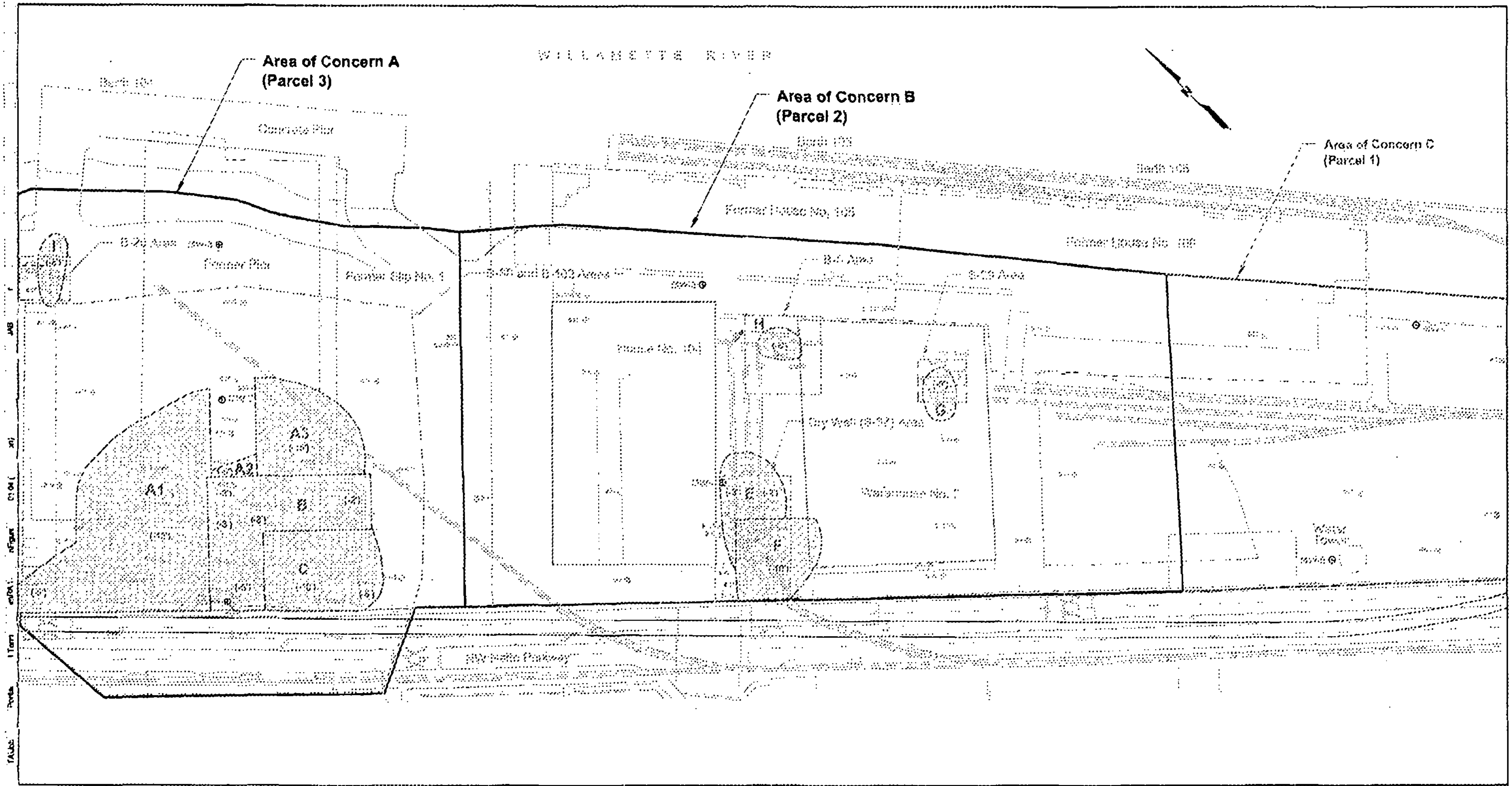
- Maul Foster and Alongi, Inc., Push Probe Boring Location and Number (March 1998)
- HAI Push Probe Boring Location and Number (2000)
- HAI Monitoring Well Location and Number (2001)
- Soil Above Cleanup Levels
- Soil Exceeding Hot Spot Level
- Potential Hazardous Waste
- B-1 Excavation Area Number

0 100 200
Approximate Scale in Feet

HARTCROWSER
15230-01 3/02
Figure 3

POPT1S603661

Excavation to Reduce Risk to Support Future Site Use
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



Note: Base map prepared from an AutoCAD file provided by Olson Engineering, 8/27/01.

Legend:

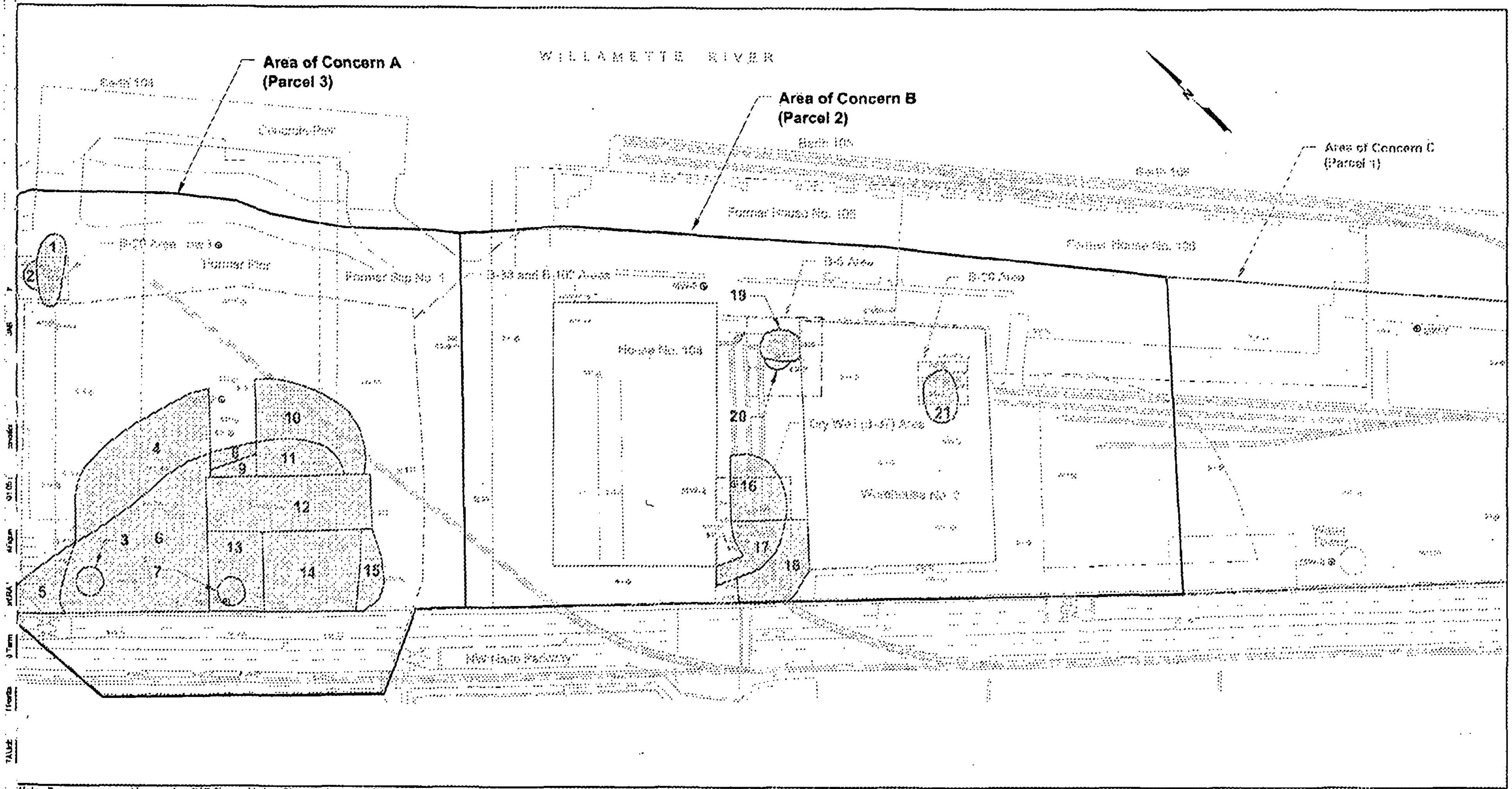
- Maul Foster and Alongi, Inc., Push Probe Boring Location and Number (March 1998)
- HAI Push Probe Boring Location and Number (2000)
- HAI Monitoring Well Location and Number (2001)
- Extent of Excavation to Reduce Risk to Support Future Site Use
- Depth of Excavation in Feet BGS

0 100 200
Approximate Scale in Feet

HARTCROWSER
15230-01 3/02
Figure 4

POPT1S603662

Final Excavation Removal Areas
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



Note: Base map prepared from an AutoCAD file provided by Olson Engineering, 8/27/01.

Legend:

Maul Foster and Alongi, Inc., Push Probe Boring Location and Number (March 1998)

HAI Push Probe Boring Location and Number (2000)

HAI Monitoring Well Location and Number (2001)

18 Final Excavation Removal Areas

0 100 200

Approximate Scale in Feet

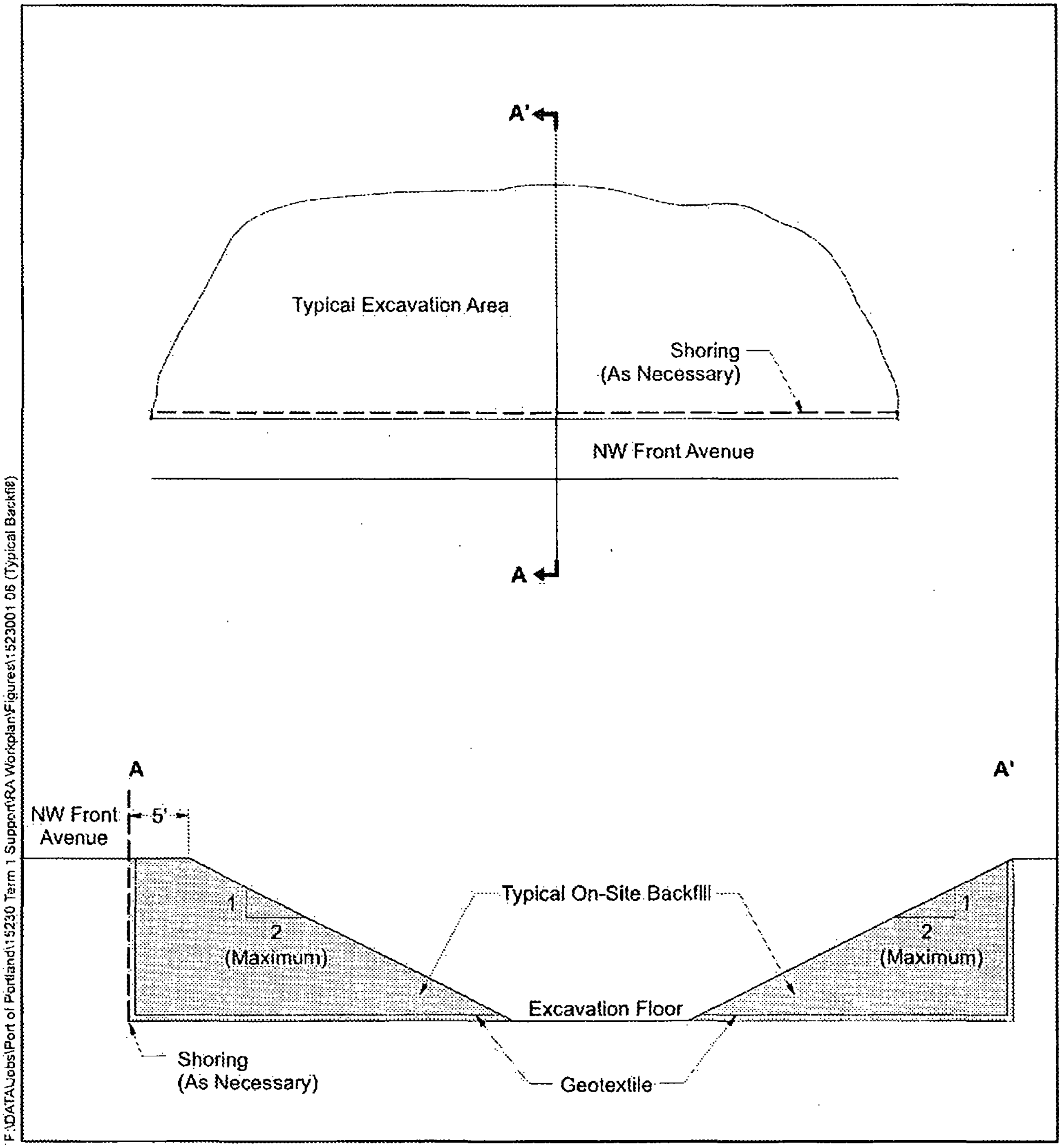
HARTCROWSER

15230-01 3/02

Figure 5

POPT1S603663

Typical Backfill Schematic
Terminal 1 South Removal Action
Port of Portland, Portland, Oregon



NOT TO SCALE

HARTCROWSER
15230-01 *3/02*
Figure 6

APPENDIX A
FIELD AND QA/QC PROCEDURES

APPENDIX A
FIELD AND QA/QC PROCEDURES

This appendix presents the field and sampling procedures and the analytical testing program that Hart Crowser will use to complete the field and analytical work for this project. Quality assurance and quality control (QA/QC) procedures are also discussed in this appendix.

1.0 FIELD AND SAMPLING PROCEDURES

The locations and basis for soil sampling are discussed in the Work Plan. Soil samples collected from the excavation floor and sidewalls will be used to verify the removal action cleanup objectives have been attained, document remaining soil contaminant concentrations, and assist in future risk-based calculations. Soil samples collected from the stockpiles will be used for waste designation. The field and sampling procedures include the following:

- Collection of soil samples from the excavation floor and sidewalls; and
- Collection of soil samples from the stockpiles.

1.1 Soil Sample Collection

Soil samples will be collected from the excavation floor and sidewalls as well as from the stockpiles. Field sampling methods will depend on whether samples are collected from the excavation areas (i.e., floor or sidewalls) or stockpiles.

Excavation Floor and Sidewalls. Samples will be taken from the excavation floor and sidewalls to provide representative coverage. If the excavation is sloped so that it may be safely entered, discrete soil samples will be collected with a stainless steel spoon directly from the excavation floor. Prior to obtaining the sample, we will remove surficial soil with a shovel or stainless steel spoon to expose fresh soil. Otherwise, samples will be collected from the excavator bucket after obtaining a representative scoop from a location designated by Hart Crowser personnel. The material will be placed in laboratory-supplied sample jars using the stainless steel spoon.

Stockpile Collection. Soil samples will be collected from stockpiles generated from areas previously defined as a potential for disposal as hazardous waste (primarily metals). One composite sample will be collected for each 200 cubic yards (or portion thereof) of soil in each stockpile. Composite samples will be collected by obtaining equal aliquots from five locations in the stockpile. The aliquots will be placed in a stainless steel bowl, mixed thoroughly, and placed in

POPT1S603666

a laboratory supplied sample jar using the stainless steel spoon. Two jars will be filled from the bowl.

Field observations will be maintained in field log notes. These observations will include the following:

- Sampling location;
- Soil characteristics (odor, sheen, presence of wood or other debris, staining, color, grain size); and
- Stockpile volumes.

Field screening. Collected soil samples will be screened in the field for the presence of volatile organic compounds (VOCs) using a photoionization detector (PID) and for oil using a sheen test. Please see Section 1.2 for a more detailed discussion of field screening techniques.

Sample Containers and Labeling. All sample containers will be clean containers supplied by the analytical laboratory. Specific container requirements for samples and holding times will be discussed with the analytical laboratory prior to sample collection and will be in accordance with the container requirements and holding times presented in Table A-2.

Sample containers will be fully filled, leaving no headspace. Each soil sample will be assigned a unique, 6-digit alphanumeric identifier. The 6-digit sample identification will include the sampler (HC), the sample type (SF for soil floor sample, SW for soil sidewall samples, SP for stockpile samples) and a unique 2-digit, sequential sample number (e.g., HC-SF-01, HC-SW-01, HC-SP-01). Sample labels will include the project number, sample number, depth, date and time of collection, and sampler's initials.

Sample Storage and Shipment. All samples will be stored in a cooler cooled with ice or blue ice to 4°C. The samples will be delivered the same day to the analytical laboratory for chemical analysis. Chain of custody will be maintained and documented at all times.

1.2 Field Screening

Headspace Measurements. PID headspace measurements will be made on soil samples to assess the relative presence of VOCs. The PID only provides a qualitative indication of the presence of VOCs and is not compound or concentration-specific. Samples will be placed in glass jars (filled less than half full), covered with aluminum foil prior to capping, and allowed to warm to ambient temperature. PID measurements will be made within one hour of collection by pushing a 10.2eV probe through the foil cover. Measurements will be recorded in field notes.

Sheen Tests. Sheen tests will be conducted on soil samples to assess if petroleum hydrocarbons (i.e., oil) are present. A small portion of a sample is placed in a wide-mouth, glass jar filled with water. The presence of petroleum hydrocarbons is indicated if a sheen is produced on the water surface in the jar. Observations will be recorded in our field notes.

1.3 Decontamination

To prevent sample contamination, all sampling equipment (stainless steel spoons and bowls) will be cleaned using an initial freshwater rinse, successive washes will alconox solution, and a final rinse with deionized water prior to and between collection activities. To avoid cross-contamination of samples, fresh gloves will be worn for each new sampling location. Decontamination water will be applied to the excavated area.

2.0 ANALYTICAL TESTING PROGRAM

An analytical testing program will be performed to assess the chemical quality of the soil for this project. Analytical laboratory QA/QC procedures are discussed in Section 3.0.

Table A-1 summarizes the rationale for analyses and the anticipated number of samples for each analysis. Detection limit goals for each analytical method are presented in Table A-3. All samples will be collected and handled using methods described in Section 1 of this appendix.

Confirmation Soil Sample Analysis. Confirmation soil samples collected from the excavation area (i.e., floor and sidewalls) will be submitted for chemical analyses. The sample analysis program consists of the following analytes and methods:

- Diesel and heavy oil range hydrocarbons using Northwest TPH-Dx;
- Polynuclear aromatic hydrocarbons (PAHs) using EPA Method 8270-SIM; and
- Total metals using EPA Method 6020/7471A (RCRA 8).

Stockpile Soil Sample Analysis. Soil samples collected from stockpiles will be submitted for chemical analyses. The sample analysis program consists of the following analytes and methods:

- Diesel and heavy oil range hydrocarbons using Northwest TPH-Dx; and
- TCLP metals using EPA Method 1311/6010A (RCRA 8).

3.0 QUALITY CONTROL/QUALITY ASSURANCE PROGRAM

3.1 Quality Assurance Objectives for Data Management

The general QA objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to document remaining soil concentrations and verify removal action cleanup objectives have been attained. Data collected during the removal action may be used in a residual risk assessment. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain of custody procedures (see Section 3.3).

Method detection limits and analytical results will be compared to action levels for each parameter in media of concern. The detection limits listed in Table A-3 are the expected detection limits, based upon laboratory calculations and experience.

Specific QA objectives are as follows:

1. Establish sampling techniques that will produce analytical data representative of the media (e.g., soil or groundwater) being measured.
2. Collect and analyze a sufficient number of duplicate field samples to establish sampling precision. Field duplicate samples will be used to establish precision among replicate samples collected from the same sample location. Laboratory duplicates of the same sample will provide a measure of precision within that sample (sample homogeneity).
3. Analyze a sufficient number of analytical duplicate samples to assess the performance of the analytical laboratory.
4. Analyze a sufficient number of blank, standard, duplicate, spiked, and check samples within the laboratory to evaluate results against numerical QA goals established for precision and accuracy.

Precision, accuracy, representativeness, completeness, and comparability parameters used to indicate data quality are defined below.

3.1.1 Precision

Precision is a measure of the reproducibility of data under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Analysis of field duplicate samples will serve to measure the precision of sampling. Field and laboratory duplicate measurements will be carried out with approximately a 10 percent frequency for each sample matrix and 5 percent frequency for laboratory samples.

3.1.2 Accuracy

Accuracy is the measure of error between the reported test results and the true sample concentration. True sample concentration is never known due to analytical limitations and error. Consequently, accuracy is inferred from the recovery data from spiked samples.

Because of difficulties with spiking samples in the field, the laboratory will spike samples. The laboratory shall perform sufficient spike samples of a similar matrix (water or soil) to allow the computation of the accuracy. For analyses of less than five samples, surrogate spikes may be performed on a batch basis.

Perfect accuracy is 100 percent recovery.

3.1.3 Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration of the chemical parameters in the medium sampled.

Sampling procedures, as well as sample-handling protocols for storage, preservation, and transportation, are designed to preserve the representativeness of the samples collected. Proper documentation will confirm that protocols are followed. This helps to assure the sample identification and integrity.

Laboratory method blanks will be run in accordance with established laboratory protocols.

3.1.4 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is essentially that a sufficient amount of valid data be generated to allow for the evaluation of site cleanup.

3.1.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The objective of this Quality Assurance Program is to assure all data developed during the removal action are comparable. Comparability of the data will be assured by using EPA-defined procedures, which specify sample collection, handling, and analytical methods. The comparability of past data will be evaluated during the investigation, if possible, by assessing the techniques used for sample collection and analysis.

3.1.6 Documentation

Essentially EPA Level III documentation will be generated during this removal action. This level of documentation is generally considered legally defensible and consists of the following:

- Holding times;
- Field duplicate data;
- Laboratory method blank data;
- Sample data;
- Matrix/surrogate spike data; and
- Duplicate sample data.

3.2 Sampling Procedures

Sampling procedures for soil are presented above in Section 1. These procedures are designed to ensure:

- All samples collected at the site are consistent with project objectives; and
- Samples are identified, handled, and transported in a manner that does not alter the representativeness of the data from the actual site conditions.

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Quality assurance objectives for sample collection will be accomplished by a combination of the following items.

- Duplicate Samples. Duplicates will be submitted to evaluate the precision. The number of field duplicates required for this project will be at least 10 percent of the total of each sample matrix.
- Laboratory QA. Laboratory duplicate measurements will be carried out on at least 5 percent of all laboratory samples. Analytical procedures will be evaluated using the protocols of the analytical laboratory. These protocols can be submitted upon request.
- Chain of Custody. Described in Section 3.3.

Table A-1 lists the proposed quality assurance samples.

3.3 Sample and Document Custody Procedures

The various methods used to document field sample collection and laboratory operation are presented below.

3.3.1 Field Chain of Custody Procedures

Sample chain of custody refers to the process of tracking the possession of a sample from the time it is collected in the field through the laboratory analysis. A sample is considered to be under a person's custody if it is:

- In a person's physical possession;
- In view of the person after possession has been taken; or
- Secured by that person so no one can tamper with the sample or secured by that person in an area restricted to authorized personnel.

A chain of custody form is used to record possession of a sample and to document analyses requested. Each time the sample bottles or samples are transferred between individuals, both the sender and receiver sign and date the chain of custody form. When a sample shipment is transported to the laboratory, a copy of the chain of custody form is included in the transport container (i.e., ice chest).

The chain of custody forms are used to record the following information:

- Sample identification number;

- Sample collector's signature;
- Date and time of collection;
- Description of sample;
- Analyses requested;
- Shipper's name and address;
- Receiver's name and address; and
- Signatures of persons involved in chain of custody.

3.3.2 Laboratory Operations

The analytical laboratory has a system in place for documenting the following laboratory information:

- Calibration procedures;
- Analytical procedures;
- Computational procedures;
- Quality control procedures;
- Bench data;
- Operating procedures or any changes to these procedures; and
- Laboratory notebook policy.

Laboratory chain of custody procedures provide the following:

- Identification of the responsible party (sample custodian) authorized to sign for incoming field samples and a log consisting of sequential lab-tracking numbers; and
- Specification of laboratory sample custody procedures for sample handling, storage, and internal distribution for analysis.

3.3.3 Corrections to Documentation

All original data are recorded in field notes and on chain of custody forms using indelible ink. Documents will be retained even if they are illegible or contain inaccuracies that require correction.

If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and initialing and dating the correction. Any subsequent error discovered on a document is corrected, initialed, and dated by the person who made the entry.

3.4 Equipment Calibration Procedures and Frequency

All instruments and equipment used during this project will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations. Operation, calibration, and maintenance will be performed by laboratory personnel fully trained in these procedures.

The PID used on site will be calibrated on a daily basis according to the manufacturer's specifications. The PID preferred by Hart Crowser field personnel utilizes a 10.2 eV probe and is calibrated using a manufacturer-supplied standard gas (isobutylene, equivalent to 34 ppm benzene). The PID is also used as a safety tool. The PID will be used to monitor air during activities where vapors may be present in the breathing space.

3.5 Analytical Procedures

All samples will be analyzed using essentially SW 846 analytical protocols for the parameters identified above in Section 2. Table A-1 lists analytical parameters and test methods.

3.6 Data Reduction, Validation, and Reporting

Reports generated in the field and laboratory will be included as an appendix to the draft and final removal action report.

The Task Manager will assure validation of the analytical data. The laboratory generating analytical data for this project will be required to submit results that are supported by sufficient backup and QA/QC data to enable the reviewer to determine the quality of the data. Validity of the laboratory data will be determined based on the objectives outlined in Section 3.1 - Quality Assurance Objectives for Data Management. Data validity will also be determined based upon the sampling procedures and documentation outlined in Sections 3.2 and 3.3 of this Appendix. Upon completion of the review, the Task Manager will be responsible for assuring development of a QA/QC report on the analytical data. All data will be stored and maintained according to the standard procedures of the laboratory. The method of data reduction will be described in the final report.

3.7 Performance Audits

Performance audits are an integral part of an analytical laboratory's standard operating procedures and are available upon request.

3.8 Corrective Actions

If the quality control audit detects unacceptable conditions or data, the Project Manager will be responsible for developing and initiating corrective action. The Task Manager will be notified if the nonconformance is significant or requires special expertise. Corrective action may include the following:

- Reanalyzing the samples, if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data and acknowledging level of uncertainty or inaccuracy by flagging the data.

3.9 Quality Assurance Reports

The Task Manager will prepare a QA/QC evaluation of the data collected during the removal action activities for inclusion in the final report. In addition to an opinion regarding the validity of the data, the QA/QC evaluation will address the following:

- Any adverse conditions or deviations from the Sampling and Analysis Plan (SAP);
- Assessment of analytical data for precision, accuracy, and completeness;
- Significant QA problems and recommended solutions; and
- Corrective actions taken for any problems previously identified.

Table A-1 - Anticipated Sample Number and Analysis
Terminal 1 South Removal Action Work Plan
Portland, Oregon

Sample Matrix and Type	Sample Location	Sample Type	Analyses Requested	Anticipated Number of Samples	Rationale for Analysis
Soil Samples					
Total Petroleum Hydrocarbons as Diesel	Excavation Sidewall Excavation Floor	Discrete	NWTPH-Dx	40	Confirmation sampling in excavation to verify removal action cleanup objectives have been attained. Assess remaining soil concentrations.
TCLP Metals	Stockpiles	Composite	EPA 1311/6010A	4	Characterize excavated soil for disposal.
Total Metals	Excavation Sidewall Excavation Floor	Discrete	EPA 6020/7471A	4	Confirmation sampling in excavation to verify removal action cleanup objectives have been attained. Assess remaining soil concentrations.
PAHs	Excavation Sidewall Excavation Floor	Discrete	EPA 8270-SIM	10	Confirmation sampling in excavation to verify removal action cleanup objectives have been attained. Assess remaining soil concentrations.
Duplicate	Excavation Sidewall Excavation Floor	Discrete	NWTPH-Dx EPA 8270-SIM	4	QA/QC.

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Acronyms:
EPA: Environmental Protection Agency
TCLP: Toxicity Characteristic Leaching Procedure
PAHs: Polynuclear Aromatic Hydrocarbons

Table A-2 - Expected Sample Container Requirements
Terminal 1 South Removal Action Work Plan
Portland, Oregon

Analysis	Method	Container	Preservative	Storage Temperature	Holding Time
Soil					
Total Petroleum Hydrocarbons as Diesel	NWTPH-Dx	8-oz wide-mouth glass	none	4°C	14 days
TCLP Metals	EPA 1311/6010A	8-oz wide-mouth glass	none	4°C	6 months (Hg 28 days)
Total Metals	EPA 6020/7471A	8-oz wide-mouth glass	none	4°C	6 months (Hg 28 days)
PAHs	EPA 8270-SIM	8-oz wide-mouth glass	none	4°C	14 days

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Note:
1. The number of required sample containers will be determined and supplied by the analytical laboratory. Some analytical sample aliquots may be taken from the same container.

Acronyms:
EPA: Environmental Protection Agency
TCLP: Toxicity Characteristic Leaching Procedure
PAHs: Polynuclear Aromatic Hydrocarbons

Table A-3 - Detection Limit Goals
Terminal 1 South Removal Action Work Plan
Portland, Oregon

Method	Analyte	Detection Limit Goals
Soil Samples		
Total Petroleum Hydrocarbons as Diesel and oil		[mg/kg]
	Diesel Range Hydrocarbons	25
(NWTPH-Dx)	Heavy Oil Range Hydrocarbons	50
TCLP Metals		[mg/L]
(EPA 1311/6010A)	Arsenic	0.005
	Barium	0.005
	Cadmium	0.005
	Chromium	0.005
	Lead	0.005
	Mercury	0.005
	Selenium	0.005
	Silver	0.005
Total Metals		[mg/kg]
(EPA 6020/7471A)	Arsenic	0.5
	Barium	0.5
	Cadmium	0.5
	Chromium	0.5
	Lead	0.5
	Mercury	0.5
	Selenium	0.5
	Silver	0.5
PAHs		[µg/kg]
(EPA 8270-SIM)	Acenaphthene	13.4
	Acenaphthylene	13.4
	Anthracene	13.4
	Benzo (a) Anthracene	13.4
	Benzo (a) Pyrene	13.4
	Benzo (b) Fluoranthene	13.4
	Benzo (g,h,I) Perylene	13.4
	Benzo (k) Fluoranthene	13.4
	Chrysene	13.4
	Dibenzo (a,h) Anthracene	13.4
	Fluoranthene	13.4
	Fluorene	13.4
	Ideno (1,2,3-cd) Pyrene	13.4
	Napthalene	13.4
	Phenanthrene	13.4
	Pyrene	13.4

F:\DATA\Jobs\Port of Portland\15230 Term 1 Support\RA Workplan\Appendices\AppA\Tables.xls

Acronyms:
EPA: Environmental Protection Agency
TCLP: Toxicity Characteristic Leaching Procedure
PAHs: Polynuclear Aromatic Hydrocarbons

APPENDIX B
HEALTH AND SAFETY PLAN

APPENDIX B - HEALTH AND SAFETY PLAN
REMOVAL ACTION WORK PLAN
TERMINAL 1 SOUTH
2100 NW FRONT AVENUE, PORTLAND, OREGON
PREPARED FEBRUARY 26, 2002

SUMMARY INFORMATION

EMERGENCY CONTINGENCY INFORMATION

SITE LOCATION	Terminal 1 South 2100 NW Front Avenue Portland, Oregon 97209
NEAREST HOSPITAL	Good Samaritan Hospital 1015 NW 22nd Avenue Portland, Oregon (503) 413-7711 The route to hospital is shown on Figure HSP-1.
EMERGENCY RESPONDERS	Police Department....911 Fire Department....911 Ambulance....911
EMERGENCY CONTACTS	Hart Crowser, Portland Office ....(503)620-7284 National Response Center....(800)424-8802 Oregon Accident Response System....(800)452-0311 Environmental Response Team....(503)283-1150 Poison Control Center....(503)494-8968 Chemtrec....(800)424-9300

In the event of an emergency, call for help as soon as possible.
Give the following information:

- WHERE the emergency is - use cross streets or landmarks
- PHONE NUMBER you are calling from
- WHAT HAPPENED - type of injury
- HOW MANY persons need help
- WHAT is being done for the victim(s)
- YOU HANG UP LAST - let the person you called hang up first

CORPORATE HEALTH AND SAFETY PLAN

The attached General Health and Safety Plan and Attachments A and B cover each of the 11 required plan elements as specified in OSHA 1910.120. The reader is advised to thoroughly review the entire plan. When used together with the Hart Crowser Corporate Health and Safety Plan, this site-specific plan meets all applicable regulatory requirements.

SITE HEALTH AND SAFETY PLAN SUMMARY

Site Location and Description

LOCATION: 2100 NW Front Avenue, Portland, Oregon

LAND USE OF AREA SURROUNDING FACILITY: Industrial

SITE ACTIVITIES: Soil Excavation, Soil Sampling, and Construction Observation

PROPOSED DATE OF ACTIVITY: April - May 2002

Site Hazards and Preventative Measures

POTENTIAL SITE CONTAMINANTS: Petroleum hydrocarbons; polynuclear aromatic hydrocarbons; and metals.

ROUTES OF ENTRY: Skin contact with soil, incidental ingestion of soil, and inhalation of dust and volatiles.

PROTECTIVE MEASURES: Engineering controls, safety glasses, safety boots, hard hat, gloves, protective clothing, and respirators, as necessary

MONITORING EQUIPMENT: Photoionization Detector (PID) with 10.2 eV lamp, visual and olfactory indications

Chain of Command

The chain of command for Health and Safety in this project involves the following individuals:

CORPORATE H&S MANAGER: Elisabeth Black, C.I.H.

PROJECT MANAGER: Herb Clough, P.E.

PROJECT H&S OFFICER: Levi Fernandes

FIELD H&S MANAGER: Levi Fernandes

Route to Hospital

Terminal 1 South Removal Action

Port of Portland, Portland, Oregon

F:\DATA\Jobs\Port of Portland\15230 Term 1 Support\RA Workplan\Figures\1523000 HSP-1 (Route to Hospital)

Note: Base map prepared from the USGS 7.5-minute quadrangle of Portland, OR dated 1990.

Good Samaritan Hospital
1015 NW 22nd Avenue
Portland, Oregon 97210
(503) 413-7711

HARTCROWSER
15230 ***3/02***
Figure HSP-1

Record of Health and Safety Communication

PROJECT NAME: Terminal 1 South RA PROJECT NUMBER: 15230

SITE CONTAMINANTS (see Attachment B):

PPE REQUIREMENTS (check all that apply):

__Safety glasses
__Safety boots
__Hard hat
__Gloves (specify)
__Clothing (specify)
__Respirator (specify)
__Other (specify)

The following personnel have reviewed a copy of the Summary Information regarding the site, the General Health and Safety Plan, and Attachments A and B. By signing below, these personnel indicate that they have read the plan, including all referenced information, and that they understand the requirements which are detailed for this project.

PRINTED NAME	SIGNATURE	PROJECT DUTIES	DATE

General Health and Safety Plan
Hart Crowser, Inc.
Portland, Oregon

February - May 2002

CONTENTS

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TABLES

FIGURES

ATTACHMENTS

ATTACHMENT A TABLES

GENERAL HEALTH AND SAFETY PLAN

1.0 INTRODUCTION

1.1 Purpose and Regulatory Compliance

This site-specific Health and Safety Plan (H&S Plan) addresses procedures to minimize the risk of chemical exposures, physical accidents to on-site workers, and environmental contamination. The H&S Plan covers each of the 11 required plan elements as specified in OSHA 1910.120. To help the reader find this required information, Table 1 shows the major sections where each of these elements is discussed. Additional supporting information is presented throughout this plan and the attachments. The reader is advised to thoroughly review the entire plan. When used together with the Hart Crowser Corporate H&S Plan, this site-specific plan meets all applicable regulatory requirements.

1.2 Distribution and Approval

This H&S Plan will be made available to all Hart Crowser personnel involved in field work on this project. It will also be made available to subcontractors and other non-employees who may need to work on the site. For non-employees, it must be made clear that the plan represents minimum safety procedures and that they are responsible for their own safety while present on the site. The plan has been approved by the Hart Crowser Health and Safety (H&S) Manager. By signing the documentation form provided with this plan, project workers also certify their approval and agreement to comply with the plan.

1.3 Chain of Command

The chain of command for Health and Safety in Hart Crowser projects involves the following individuals: the Corporate H&S Manager, the Project Manager, the Project H&S Officer, and the Field H&S Manager. In some cases, based on the complexity of the project and level of staffing, the project and field related H&S positions may be combined. If the specified Field H&S Manager is unable to be present on the site during work activities, the Project H&S Officer will serve as the on-site safety officer or, alternatively, another Field H&S Manager will be designated.

Corporate H&S Manager: The Hart Crowser Corporate H&S Manager has overall responsibility for preparation and modification of this H&S Plan. In the event that health and safety issues arise during site operations, he will attempt to resolve them in discussion with the appropriate members of the project team.

Project Manager: The Project Manager is charged with overall responsibility for the successful outcome of the project. The Project Manager, in consultation with the Corporate H&S Manager, makes final decisions regarding questions concerning the implementation of the Site H&S Plan. The Project Manager may delegate this authority and responsibility to the Project and/or Field H&S Managers.

Project H&S Officer: The Project H&S Officer has overall responsibility for health and safety on this project. This individual ensures that everyone working on this project understands this H&S Plan. The project manager will maintain liaison with the Hart Crowser Project Manager so that all relevant safety and health issues are communicated effectively to project workers.

Field H&S Manager: The Field H&S Manager is responsible for implementing this H&S Plan in the field. This individual also observes subcontractors to verify that they are following these procedures, at a minimum. The Field H&S Manager will also assure that proper protective equipment is available and used in the correct manner, decontamination activities are carried out properly, and that employees have knowledge of the local emergency medical system should it be necessary.

1.4 Site Activities

A summary of site activities is attached to the front of this H&S Plan. A more detailed discussion of site activities is presented in Attachment A.

2.0 HAZARD EVALUATION AND CONTROL MEASURES

2.1 Toxicity of Chemicals of Concern

The chemicals of concern which may be present at this site are presented in Attachment B. Pertinent toxicological properties of these chemicals are discussed in this attachment.

2.2 Potential Exposure Routes

Inhalation. Exposure could occur via this route if: 1) volatile chemicals become airborne during site activities, especially upon exposure to open air, warm temperatures, and sunlight; or 2) dust is generated during the soil excavation or by walking or driving over contaminated soils. Air monitoring and control measures specified in Attachment A will minimize the possibility for inhalation of site contaminants.

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Skin Contact. Exposure could occur via this route if contaminated soil, product, or water contacts the skin or clothing. Dusts generated during soil movement may also settle on exposed skin and clothing of site workers. Protective clothing and decontamination activities specified in this plan will minimize the potential for skin contact with the contaminants.

Ingestion. Exposure could occur via this route if: 1) individuals eat, drink, or perform other hand-to-mouth contact in the contaminated (exclusion) zones, or 2) contaminated water is splashed into one's mouth during site activities. In the former case, decontamination procedures established in this plan will minimize the inadvertent ingestion of contaminants. In the latter case, splash protection or closing one's mouth when working around contaminated water will minimize potential exposure.

2.3 *Air Monitoring and Action Levels*

Air monitoring will be conducted to determine possible hazardous conditions and to confirm the adequacy of personal protection equipment. The results of the air monitoring will be used as the basis for specifying personal protective equipment and determining the need to upgrade protective measures. Please see Attachment A for site-specific air monitoring procedures and Table A-2 for air monitoring action levels.

2.4 *Fire and Explosion Hazard*

Potentially flammable or explosive conditions are not expected to be encountered in this project. To address emergency situations, however, an ABC dry chemical fire extinguisher will be available at the site.

2.5 *Heat and Cold Stress*

Heat Stress

Use of impermeable clothing reduces the cooling ability of the body due to evaporation reduction. This may lead to heat stresses such as heat exhaustion, heat cramps, or heat stroke. If such conditions occur during site activities, we will maintain appropriate work-rest cycles and drink water or electrolyte-rich fluids (Gatorade® or equivalent) to minimize heat stress effects. Also, when ambient temperatures exceed 70°F, we will conduct monitoring of employee pulse rates.

Each employee will check his or her own pulse rate at the beginning of each break period. Each employee will take their pulse at the wrist for 6 seconds, and multiply by 10. If the pulse rate exceeds 110 beats per minute, then reduce the length of the next work period by one-third.

Example: After a one-hour work period at 80°F, a worker has a pulse rate of 120 beats per minute. The worker must therefore shorten the next work period by one-third, resulting in a work period of 40 minutes until the next break.

Hypothermia. Hypothermia results from abnormal cooling of the core body temperature. It is caused by exposure to a cold environment, and wind-chill as well as wetness or water immersion can play a significant role. The following section discusses signs and symptoms as well as treatment for hypothermia.

Signs of Hypothermia. Typical warning signs of hypothermia include fatigue, weakness, incoordination, apathy, and drowsiness. A confused state is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink. Body temperatures below 90°F require immediate treatment to restore temperature to normal.

Treatment of Hypothermia. Current medical practice recommends slow rewarming as treatment for hypothermia, followed by professional medical care. This can be accomplished by moving the person into a sheltered area and wrapping with blankets in a warm room. In emergency situations where body temperature falls below 90°F and heated shelter is not available, use a sleeping bag, blankets and/or body heat from another individual to help restore normal body temperature.

2.6 Other Physical Hazards

Trips/Falls

As with all field work sites, caution will be exercised to prevent slips on rain slick surfaces, stepping on sharp objects, etc. Work will not be performed on elevated platforms without fall protection. All excavations will be temporarily enclosed during work with barrier tape, or similar measures will be used to prevent workers from accidentally falling into an excavation.

Confined Spaces

Confined space entry is not anticipated for this project and will not be performed without specific approval of the Project Manager and H&S Manager.

Noise

Appropriate hearing protection (ear muffs or ear plugs) will be used if high noise levels are generated. When employees work around drilling equipment, hearing protection should be worn.

2.7 *Hazard Analysis and Applicable Safety Procedures by Task*

The work tasks and associated hazards which may be anticipated during this project are described in Attachment A and presented in Table A-1.

3.0 PROTECTIVE EQUIPMENT

Table 2 presents a summary of minimum personnel protection requirements based on the potential route of contact and the potential contaminants. These requirements are classified in the designated Level D and C categories as discussed below. In this plan, Level C is presented as a modified protection level, incorporating respiratory protection only where required by site conditions and air monitoring. Situations requiring Level A or B protection are not presently anticipated for this project. Should they occur, work will stop and the H&S Plan will be amended as required prior to resuming work.

3.1 *Level D Activities*

Workers performing general site activities where skin contact with free product or contaminated materials is not likely and inhalation risks are not expected will wear regular work clothes, or regular or polyethylene coated Tyvek® coveralls, eye protection, hard hat (as required), nitrile or neoprene coated work gloves (as required), and safety boots.

3.2 *Level C Activities*

Workers performing site activities where skin contact with free product or contaminated materials is possible will wear chemically-resistant gloves (nitrile, neoprene, or other appropriate outer gloves, and surgical inner gloves). Workers will use face shields or goggles as necessary to avoid splashes in the eyes or face. When performing activities where skin exposure is possible, workers will use polyethylene-coated Tyvek® or other chemically-resistant suits or rain gear. Workers will make sure the protective clothing and gloves are suitable for the types of chemicals, which may be encountered on the site.

When performing activities in which inhalation of chemical vapors or contaminated dusts is a concern, workers will wear full-face air-purifying respirators (APR) as specified in Table 2. If respirators are used, workers will change cartridges on a daily basis, at minimum. Cartridges should be changed more frequently if vapors are detected inside the respirator or other symptoms of breakthrough are noted (irritation, dizziness, breathing difficulty, etc.).

4.0 SAFETY EQUIPMENT LIST

The following Safety Equipment must be available on the site:

- Fire Extinguisher - 10 lb ABC CO_2
- First Aid Kit
- Eye Wash Kit
- Full-face APR - Organic Vapor/Particulate Filter Cartridge (MSA GMD or GMD-H or equivalent)
- Hard Hat
- Tyvek Coveralls/Polycoated Tyvek® Coveralls
- PVC (or similar) rainsuit
- Neoprene Steel-Toed Boots
- Nitrile Outer Gloves/Latex Inner Gloves
- Neoprene Outer Gloves/Latex Inner Gloves

Additional equipment may also be present depending on-site activities may include:

- Photoionization Detector (PID)
- MSA 361 or equivalent
- Mobile Telephone
- Latex Boot Covers

5.0 EXCLUSION AREAS

Wherever migration of chemicals from the work area is a possibility, or as otherwise required by regulations or client specifications, site control will be maintained by establishing clearly identified work zones. These will include the exclusion zone, contaminant reduction zone, and support zone, as discussed below. The site work zones are presented on Figure 1.

5.1 Exclusion Zone

Exclusion zones will be established around each hazardous waste activity location. Only persons with appropriate training and authorization from the Field H&S Manager will enter this perimeter while work is being conducted there. Traffic cones, barrier tapes, and warning signs (or equivalent measures) will be used as necessary to establish the zone boundary. Plastic stanchions will be placed as required to prevent unauthorized access. Caution tape or signs will be posted in plain view of approach from either direction.

5.2 Contamination Reduction Zone

A contamination reduction zone will be established just outside each temporary exclusion zone to decontaminate equipment and personnel as discussed below. This zone will be clearly delineated from the exclusion zone and support zone using the means noted above. Care will be taken to prevent the spread of contamination from this area. Spent decontamination fluids and used protective clothing will be disposed in a manner consistent with the toxicity of the chemicals of concern. The drums, after labeling, will be moved to central storage location(s) on the site pending disposal.

5.3 Support Zone

A support zone will be established outside the contamination reduction area to stage clean equipment, don protective clothing, take rest breaks, etc. This zone will be clearly delineated from the contaminant reduction zone using the means noted above.

6.0 MINIMIZATION OF CONTAMINATION

In order to make the work zone procedure function effectively, the amount of equipment and number of personnel allowed in contaminated areas must be minimized. In addition, the amounts of soil, water, or other media collected should not exceed what is needed for laboratory analysis and record samples. Workers will not kneel on contaminated ground, stir up unnecessary dust, or perform any practice that increases the probability of hand-to-mouth transfer of contaminated materials. Workers will use plastic drop cloths and equipment covers where appropriate. Eating, drinking, chewing gum, smoking or using smokeless tobacco are forbidden in the exclusion zone.

7.0 DECONTAMINATION

Decontamination is necessary to limit the migration of contaminants from the work zone(s) onto the site or from the site into the surrounding environment. Equipment and personnel decontamination are discussed in the following sections, and the following types of equipment will be available to perform these activities:

- Boot and Glove Wash Bucket and Rinse Bucket
- Scrub Brushes - Long Handled
- Spray Rinse Applicator
- Plastic Garbage Bags
- 5-Gallon Container Alkaline Decon Solution

7.1 Equipment Decontamination

Proper decontamination (decon) procedures will be employed to ensure that contaminated materials do not contact individuals and are not spread from the site. These procedures will also ensure that contaminated materials generated during site operations and during decontamination are managed appropriately.

All non-disposable equipment will be decontaminated in the contamination reduction zone. Prior to demobilization, all contaminated portions of heavy equipment should be thoroughly cleaned. Heavy equipment may require steam cleaning. Soil and water sampling instruments should be cleaned with detergent solutions in portable buckets.

7.2 Personnel Decontamination

Personnel working in exclusion zones will perform a mini-decontamination in the contamination reduction zone prior to changing respirator cartridges (if worn), taking rest breaks, drinking liquids, etc. They will decontaminate fully before eating lunch or leaving the site. The following describes the procedures for mini-decon and full decon activities.

Mini-decon procedure:

1. In the contamination reduction zone, wash and rinse outer gloves and boots in portable buckets.
2. Inspect protective outer suit, if worn, for severe contamination, rips or tears.
3. If suit is highly contaminated or damaged, full decontamination as outlined below will be performed.
4. Remove outer gloves. Inspect and discard if ripped or damaged.
5. Remove respirator (if worn) and clean off sweat and dirt using premoistened towelettes. Deposit used cartridges in plastic bag.
6. Replace cartridges and outer gloves, and return to work.

Full decontamination procedure:

1. In the contamination reduction zone, wash and rinse outer gloves and boots in portable buckets.
2. Remove outer gloves and protective suit and deposit in labeled container for disposable clothing.
3. Remove respirator, and place used respirator cartridges (if end of day) in container for disposable clothing.
4. If end of day, thoroughly clean respirator and store properly.
5. Remove inner gloves and discard into labeled container for disposable clothing.
6. Remove work boots without touching exposed surfaces, and put on street shoes. Put boots in individual plastic bag for later reuse.
7. Immediately wash hands and face using clean water and soap.
8. Shower as soon after work shift as possible.

8.0 DISPOSAL OF CONTAMINATED MATERIALS

All disposable sampling equipment and materials will be placed inside of two 10 mil polyurethane bags or other appropriate containers and placed in storage as directed by the client. If storage is unavailable on the site, or if other hazardous wastes will not be gathered and collected as part of this effort, then disposable supplies will be removed from the site with the personnel.

9.0 SITE SECURITY AND CONTROL

Site security and control will be the responsibility of the Project Manager. The "buddy-system" will be used when working in designated hazardous areas. Any security or control problems will be reported to appropriate authorities.

10.0 SPILL CONTAINMENT

Sources of bulk chemicals subject to spillage are not expected to be encountered in this project. Accordingly, a spill containment plan is not required for this project.

11.0 EMERGENCY RESPONSE PLAN

The Hart Crowser Emergency Response Plan outlines the steps necessary for appropriate response to emergency situations. The following paragraphs summarize the key Emergency Response Plan procedures for Hart Crowser projects.

11.1 Plan Content and Review

The principal hazards addressed by the Emergency Response Plan include the following: fire or explosion, medical emergencies, uncontrolled contaminant release, and situations such as the presence of chemicals above exposure guidelines or inadequate protective equipment for the hazards present. However, in order to help anticipate potential emergency situations, field personnel shall always exercise caution and look for signs of potentially hazardous situations, including the following as examples:

- Visible or odorous chemical contaminants;
- Drums or other containers;
- General physical hazards (traffic, moving equipment, sharp or hot surfaces, slippery or uneven surfaces, etc.);
- Possible sources of radiation;
- Live electrical wires or equipment;
- Underground pipelines or cables; and
- Poisonous plants or dangerous animals.

These and other potential problems should be anticipated and steps taken to avert problems before they occur.

The Emergency Response Plan shall be reviewed and rehearsed, as necessary, during the on-site health and safety briefing. This ensures that all personnel will know what their duties shall be if an actual emergency occurs.

11.2 Plan Implementation

The Field H&S Manager shall act as the lead individual in the event of an emergency situation and evaluate the situation. He/she will determine the need to implement the emergency procedures, in concert with other resource personnel including client representatives, the Project Manager, and the Corporate H&S Manager. Other on-site field personnel will assist the Manager as required during the emergency.

In the event that the Emergency Response Plan is implemented, the Field H&S Manager or designee is responsible for alerting all personnel at the affected area by use of a signal device (such as a hand-held air horn) or visual or shouted instructions, as appropriate.

Emergency evacuation routes and safe assembly areas shall be identified and discussed in the on-site health and safety briefing, as appropriate. The buddy-system will be employed during evacuation to ensure safe escape, and the Field H&S Manager shall be responsible for roll-call to account for all personnel.

11.3 Emergency Response Contacts

Site personnel must know whom to notify in the event of Emergency Response Plan implementation. The following information will be readily available at the site in a location known to all workers:

- Emergency Telephone Numbers – see list at the beginning of this plan;
- Route to Nearest Hospital – see list and route map at the beginning of this plan;
- Site Descriptions – see the description at the beginning of this plan; and
- If a significant environmental release of contaminants occurs, the federal, state, and local agencies noted in this plan must be immediately notified. If the release to the environment includes navigable waters also notify:

    National Response Center at (800) 424-8802
    Oregon Accident Response System at (800) 452-0311

In the event of an emergency situation requiring implementation of the Emergency Response Plan (fire or explosion, serious injury, tank leak or other material spill, presence of chemicals above exposure guidelines, inadequate personnel protection equipment for the hazards present, etc.), cease all work immediately. Offer whatever assistance is required, but do not enter work areas without proper protective equipment. Workers not needed for immediate assistance will decontaminate per normal procedures (if possible) and leave the work area, pending approval by the Field Safety Manager for re-start of work. The following general emergency response safety procedures should be followed.

11.4 Fires

Hart Crowser, Inc., personnel will attempt to control only very small fires. If an explosion appears likely, evacuate the area immediately. If a fire occurs which cannot be controlled with the 10-pound ABC fire extinguisher located in the field equipment, then immediate intervention by the local fire department or other appropriate agency is imperative. Use these steps:

- Evacuate the area to a previously agreed upon, upwind location;
- Contact fire agency identified in the site specific plan; and
- Inform Project Manager or Field H&S Manager of the situation.

11.5 Medical Emergencies

Contact the agency listed in the site-specific plan if a medical emergency occurs. If a worker leaves the site to seek medical attention, another worker should accompany the patient. When in doubt about the severity of an accident or exposure, always seek medical attention as a conservative approach. Notify the Project Manager of the outcome of the medical evaluation as soon as possible. For minor cuts and bruises, an on-site first aid kit will be available.

- If a worker is seriously injured or becomes ill or unconscious, immediately request assistance from the emergency contact sources noted in the site-specific plan. Do not attempt to assist an unconscious worker in an untested or known dangerous confined space without applying confined space entry procedures or without using proper respiratory protection, such as a self contained breathing apparatus (SCBA).
- In the event that a seriously injured person is also heavily contaminated, use clean plastic sheeting to prevent contamination of the inside of the emergency vehicle. Less severely injured individuals may also have their protective clothing carefully removed or cut off before transport to the hospital.

11.6 Uncontrolled Contaminant Release

In the event of a tank rupture or other material spill, attempt to stop and contain the flow of material using absorbents, booms, dirt, or other appropriate material.

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Prevent migration of liquids into streams or other bodies of water by building trenches, dikes, etc. Drum the material for proper disposal or contact a spill removal firm for material cleanup and disposal, as required. Observe all fire and explosion precautions while dealing with spills.

11.7 Potentially High Chemical Exposure Situations/Inadequate Protective Equipment

In some emergency situations, workers may encounter localized work area where exposure to previously unidentified chemicals could occur. A similar hazard includes the situation where chemicals are present above permissible exposure levels and/or above the levels suitable for the personnel protective equipment at hand on-site. If these situations occur, immediately stop work and evacuate the work area. Do not reenter the area until appropriate help is available and/or appropriate personnel protective equipment is obtained. Do not attempt to rescue a downed worker from such areas without employing confined space entry procedures. Professional emergency response assistance (fire department, HAZMAT team, etc.) may be necessary to deal with this type of situation.

11.8 Other Emergencies

Depending on the type of project, other emergency scenarios may be important at a specific work site. These scenarios will be considered as part of the site-specific plan and will be discussed during the on-site safety briefing, as required.

11.9 Plan Documentation and Review

The Field H&S Manager will notify the Project H&S Manager as soon as possible after the emergency situation has been stabilized. The Project Manager or H&S Manager will notify the appropriate client contacts, and regulatory agencies, if applicable. If an individual is injured, the Field H&S Manager or designate will file a detailed Accident Report with the Corporate H&S Manager within 24 hours.

The Project Manager and the Field, Project, and Corporate H&S Managers will critique the emergency response action following the event. The results of the critique will be used in follow-up training exercises to improve the Emergency Response Plan.

12.0 MEDICAL SURVEILLANCE

A medical surveillance program has been instituted for Hart Crowser employees having exposure to hazardous substances. Exams are given before assignment, annually thereafter, and upon termination. Content of exams is determined by the Occupational Medicine physician in compliance with applicable regulations and is detailed in the Corporate H&S Plan.

Each team member will have undergone a physical examination as noted above in order to verify that he/she is physically able to use protective equipment, work in hot environments, and not be predisposed to occupationally-induced disease. Additional exams may be needed to evaluate specific exposures or unexplainable illness.

13.0 TRAINING REQUIREMENTS

Hart Crowser employees who perform site work must understand potential health and safety hazards. All employees potentially exposed to hazardous substances, health hazards, or safety hazards will have completed 40 hours of off-site initial hazardous materials health and safety training or will possess equivalent training by past experience. They will also have a minimum of three days of actual field experience under the direct supervision of a trained supervisor. All employees will have in their possession evidence of completing this training. Employees will also complete annual refresher, supervisor, and other training as required by applicable regulations.

Prior to the start of each work day, the Field H&S Manager will review applicable health and safety issues with all employees and subcontractors working on the site, as appropriate. These briefings will also review the work to be accomplished, with an opportunity for questions to be asked.

14.0 REPORTING, REPORTS, AND DOCUMENTATION

Hart Crowser staff and subcontractors on this site will sign the Record of H&S Communication document, which will be kept on the site during work activities and recorded in the project files. The Field Health and Safety Report will also be completed daily by the Hart Crowser Field Representative. In the event that accidents or injuries occur during site work, the Health and Safety Manager and the client shall be immediately notified.

Table 1 - Location of Required Health and Safety Plan Elements
General Health and Safety Plan

Required Health and Safety Plan Elements*	Location in this Health and Safety Plan (Section number shown)
(A) Safety and hazard analysis	2.0 Hazard Evaluation and Control Measures (see Appendices A and B)
(B) Training	13.0 Training Requirements
(C) Personal protective equipment	3.0 Protective Equipment, 4.0 Safety Equipment List
(D) Medical surveillance	12.0 Medical Surveillance
(E) Monitoring program	2.3 Air Monitoring and Action Levels
(F) Site control	Attached Health and Safety Plan Summary, 5.0 Exclusion Areas, 9.0 Site Security and Control
(G) Decontamination	7.0 Decontamination
(H) Emergency response plan	11.0 Emergency Response Plan
(I) Confined space entry	2.6 Confined Spaces
(J) Spill containment	10.0 Spill Containment

*Required H&S Plan elements are numbered according to their listing in OSHA 1910.120.

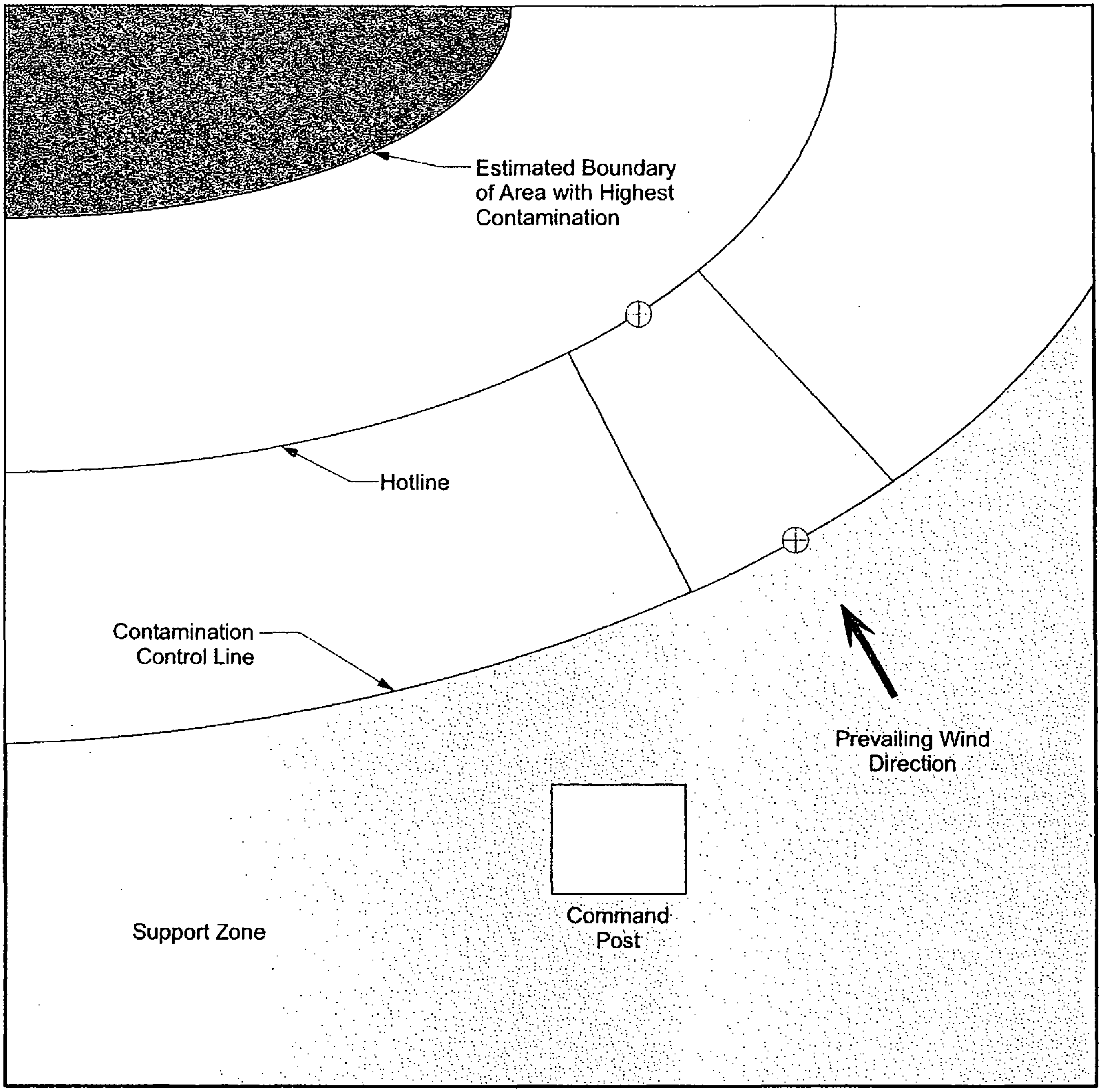
Table 2 - Minimum Personnel Protection Level Requirements
General Health and Safety Plan

Potential Route of Contact	Required Protection Level	Safety Glasses	Hard Hat	Safety Boots	Tyvek	Poly Tyvek	Nitrile Gloves	Neoprene Gloves	Half Face Respirator	Full Face Respirator
None Anticipated	Level D (a)	X	b	X						
Minor Skin Contact Possible	Level D (a)	X	b	X	X		X	X		
Skin Contamination Possible	Level C (c)	d	b	e		f	g	g		
Inhalation Possible	Level C (c)	d	b	e					h,i	h,j

Notes:

a. Level D protection required when the atmsophere contains no known hazards and work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.
b. Hard hat is required where risk of striking overhead objects exists.
c. Level C protection required when the atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin; the types of air contaminants have been identified, concentrations measured, and appropriate respirator cartridges are available; and all air-purifying respirator criteria are met.
d. Goggles, face-shield, or full-face respirator required.
e. Chemical-resistant synthetic boots required.
f. Use polyethylene-coated Tyvek or equivalent as required by site chemicals. Some chemicals may require Saranex-coated Tyvek or similar materials; consult appropriate references as required.
g. Use nitrile or neoprene as required by the chemicals. Some chemicals may require Viton or other types of materials; consult appropriate references as required.
h. Appropriate respirator cartridges include: organic vapor (MSA GMA or equivalent), combination (MSA GMA-H or equivalent), and others as required by the contaminants.
i. Half-face organic cartridge respirator required when PID readings range from 5-10 units above background, or as indicated by other site data or information.
j. Full-face organic cartridge respirator required when PID readings range from 10 to 100 units above background, whenever respirators and safety glasses are necessary, and/or eye irritation occurs.

Site Work Zones



Notes: Area dimensions are not to scale. Distances between points may vary. Decontamination facilities are located in the contamination reduction zone.

Not to Scale

Legend:

- Access Control Points
- Contamination Reduction Corridor
- Contamination Reduction Zone
- Exclusion Zone

HARTCROWSER
H&S Plan ***3/02***
Figure 1

ATTACHMENT A
SITE ACTIVITIES:
HAZARD ANALYSIS AND APPLICABLE SAFETY PROCEDURES

This attachment presents the information, by task, regarding activities being accomplished at the site. Additionally, air monitoring and underground utilities are also discussed.

Site Activities

The following work tasks will be accomplished:

- Soil excavation; and
- Soil sampling.

The associated hazards for the above activities that may be anticipated during this project are presented in Table A-1. Special task requirements are discussed in detail below.

Excavations

Soil will be removed from various areas at the site. The soil will be loaded and transported to an appropriate licensed waste disposal/treatment facility. All excavation activities will be conducted with appropriate personnel protective equipment as shown in Table 2.

Employees are cautioned to stand clear of all equipment. Noise protection will be used whenever high noise activities are in progress or are significant. Dust minimization procedures will be used as necessary, and excavations will not be conducted during periods of high wind when dusts could be dispersed off the site.

Employees are cautioned to stand clear of open excavations. Employees will not enter any excavations of 5 feet or greater depth without proper shoring or sloping.

Soil Sampling

Any soil sampling will occur under the assumption that the media is contaminated and appropriate personnel protection will be required as noted in Table 2.

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Underground Utilities

A utility locate should be completed prior to performing any underground activity that will disturb soil and have the potential for disrupting underground utilities. In the following cases, immediately stop work and evacuate the area pending further evaluation:

- If gas or vapor venting occurs during excavation;
- If the odor of natural gas is detected; or
- If it is suspected that a pipeline or utility service has been hit.

In addition, contact the proper authorities, as necessary, and report the incident to the project manager in the office.

If gas or vapor venting occurs from a soil boring, well installation, excavation, or other source, immediately position upwind from the source. If necessary, use respiratory protection. **If the odor of natural gas is detected or if it suspected that a pipeline has been hit, immediately stop work, evacuate the area, and contact the proper authorities.** Never continue to work in an area, even if PID readings, lower explosive limit (LEL), and/or hydrogen sulfide tests are acceptable, if you begin to notice strange odors or symptoms of overexposure (such as dizziness, nausea, tearing of the eyes, etc.). Do not resume work until testing shows the hazard has been removed.

Air Monitoring and Action Levels

Air monitoring will be conducted to determine possible hazardous conditions and to confirm the adequacy of personal protection equipment. The results of the air monitoring will be used as the basis for specifying personal protective equipment and determining the need to upgrade protective measures. Air monitoring equipment will be calibrated prior to use (where applicable) as specified by the instrument manuals and results will be documented in the instrument log. All equipment will be maintained as specified by the manufacturer or more frequently as required by use conditions, and repair records will be maintained with the instrument log.

Air monitoring will be conducted with a photoionization detector (H-Nu® PID with 10.2 eV lamp, or equivalent) to measure organic vapor concentration during site work activities. (The 10.2 eV lamp is specified to allow detection of halogenated compounds.) H-Nu® measurements will be taken at the start of work to verify that employee exposure levels are below the PEL. If H-Nu® measurements are 0-5 H-Nu® units (ppm) above background levels in the

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worker's breathing zones for five consecutive minutes, then site workers exposed to these levels will use air purifying respirators as specified in Table A-2. If H-Nu® measurements exceed 100 units (ppm) in the breathing zone, site work will cease pending re-evaluation of the situation by H&S Manager.

Dusts. Air monitoring will be conducted by visual inspection to determine the possible hazardous conditions and to confirm the adequacy of personal protective equipment. If visible dusts are generated, control measures such as dust suppression by watering and/or upgrading personal protective equipment will be assessed.

Olfactory. If olfactory senses detect any unfamiliar odor, work will stop until an assessment can be made to determine whether the need exists to upgrade protective measures.

Table A-1 - Hazard Analysis by Task
General Health and Safety Plan: Attachment A

Work Task	Hazards	Protective Measures
Soil Excavation	Skin contact, dust inhalation, earthwork equipment, trips/falls, under-and above-ground utilities.	Level C PPE (if needed), visual air monitoring, caution around moving equipment, utility locate.
Soil Sampling	Skin contact, vapor/dust *inhalation, soil ingestion*	Level C PPE (if needed), visual air monitoring.

Notes:
a. Protection levels are defined in Table 2.
b. Protection levels may require upgrade based on site monitoring or other information.

Table A-2 - Air Monitoring Action Levels
General Health and Safety Plan: Appendix A

Monitoring Device	Result	Action Required	Notes
H-Nu PI-101	0-5 units above background 5-100 units above background >100 units above background	Use half-face respirator Use full-face respirator Stop work; contact supervisor	a,b a,b a,b
Visual (c)	Slight dust	Use half-face respirator; begin instituting dust suppression measures.	b,d
	Moderate dust	Use full-face respirator; institute dust suppression measures.	b,d
	Very dusty conditions	Stop work; contact supervisor.	e
Olfactory	Mild Odor Detected	Use half-face respirator; monitor atmosphere with monitoring device(s).	b
	Moderate Odor Detected	Use full-face respirator; if odor is unknown, stop work and use monitoring device(s).	b
	Strong Odor Detected	Stop work; contact supervisor.	

Notes:

a. Use appropriate lamp and calibrate unit.
b. Air-purifying respirators must be used only when use criteria are met and when appropriate cartridges are available.
c. Based on previous use of dust monitoring equipment, visual monitoring for dust generation would be conservative and adequate for this project.
d. Dust suppression, i.e. watering, should be started from upwind direction.
e. Proper instigation of dust suppression earlier should avoid the possibility of this action.

ATTACHMENT B
TOXICITY OF CHEMICALS OF CONCERN

This attachment presents the information regarding chemical constituents hereafter referred to as "chemicals of concern," that may be encountered at the site.

Chemicals of Concern

Based on site information gathered to date, the following chemicals may be present at this site:

- Total Petroleum Hydrocarbons;
- Diesel;
- Gasoline;
- Polynuclear Aromatic Hydrocarbons (PAHs);
- Antimony;
- Arsenic;
- Barium;
- Cadmium;
- Chromium;
- Copper;
- Lead;
- Mercury;
- Nickel; and
- Silver.

Toxicity Information

Pertinent toxicological properties of these chemicals are discussed below. This information generally covers potential toxic effects which may occur from relatively significant acute and/or chronic exposures, and is not meant to indicate that such effects will occur from the planned site activities. In general, the chemicals which may be encountered at this site are not expected to be present at concentrations which could produce significant exposures. The types of planned work activities should also limit potential exposures at this site. Furthermore, appropriate protective and monitoring equipment will be used as discussed below to further minimize any exposures which might occur.

Standards for occupational exposures to these chemicals are included where available. Site exposures are generally expected to be of short duration and well below the level of any of these exposure limits. These standards are presented below:

C Ceiling exposure limit not to be exceeded at any time during a work day.

IDLH Exposure limit which is Immediately dangerous to life and health and is not to be exceeded at any time during a work day.

PEL Permissible exposure limit.

STEL Short term exposure limit expressed as a 15-minute time-weighted average and not to be exceeded at any time during a work day.

TWA Time-weighted average exposure limit for any 8-hour work shift of a 40-hour work week.

Total Petroleum Hydrocarbons (TPH)

Total petroleum hydrocarbons (TPH) is a generic term based on analytical test procedures for the range of hydrocarbon materials from gasoline through heavier fuel oils. These materials typically consist of n-paraffins, isoparaffins, naphthenes, and aromatics in the boiling point range from approximately 50 to 250°C. Based on materials such as gasoline and fuel oils, TPH can be expected to typically act as a central nervous system depressant, resulting in slurred speech and mental confusion. Higher doses can result in unconsciousness and possibly death from respiratory failure. Skin contact can result in irritation, dermatitis, and defatting. Liver and kidney damage can also result following acute or chronic exposure. No PEL has been established for TPH. For comparison, the PEL-TWA for gasoline is 300 ppm, with 500 ppm as a 15-minute STEL.

Diesel Fuel

Diesel fuel consists primarily of straight-chain hydrocarbons from C-10 to C-23. The most abundant constituents are typically C-16 and C-17 hydrocarbons. Some aromatics may also be present, typically contributing less than 0.1 percent of the total product. Diesel fuel can be considered similar to gasoline or kerosene in its toxic properties. Diesel may produce skin irritation, and inhalation may result in headache, nausea, and confusion. Diesel fuel has not been assigned a PEL-TWA. By comparison, the PEL-TWA for gasoline is 300 ppm with a 15-minute STEL of 500 ppm.

Gasoline

Gasoline is a mixture of more than 200 hydrocarbon and aromatic constituents with trace levels of performance additives. A typical gasoline is primarily carbon (C) C-4 to C-12 hydrocarbons, with significant levels of aromatics including benzene, ethyl benzene, toluene, and xylene. Prolonged exposure to gasoline causes irritation of the skin, eyes, and mucous membranes, and can produce defatting and dermatitis. Inhalation of gasoline vapor can cause central nervous system depression, confusion, unconsciousness, coma, and death. Liver and kidney damage can also occur. The current PEL-TWA for gasoline is 300 ppm, with a 15-minute STEL of 500 ppm. The toxicity of gasoline can also be significantly affected by the composition of benzene, which typically ranges up to 3.5 percent in motor fuel. Benzene is recognized as a human carcinogen, and the current PEL-TWA is 1 ppm with an STEL of 5 ppm.

Other potentially significant toxic materials present in association with gasoline may include the organo-lead compounds tetraethyl (TEL) and tetramethyl lead (TML). These chemicals are colorless liquids which have been used principally as anti-knock compounds in gasoline. When used as such, they are generally mixed with soluble dyes for identification purposes. In the environment, TEL is reported to decompose under sunlight to form crystals of mono-, di-, and triethyl lead compounds, which have a characteristic garlic-like odor.

TEL and TML can be toxic via inhalation, ingestion, percutaneous absorption, and skin and eye contact. Major target organs include the kidneys and the nervous, gastrointestinal, and cardiovascular systems. TEL is irritating to the eyes, and its decomposition products may be inhaled as dust, leading to irritation of the upper respiratory tract and convulsive sneezing. The dusts may also cause itching, burning, and redness of eyes and mucous membranes.

TEL and TML are also readily absorbed into the nervous system and are considerably more neurotoxic than inorganic lead. Minor intoxication by TEL or TML can result in nervous excitation, insomnia, and gastrointestinal symptoms. The most notable symptom of TEL poisoning and repeated exposure is encephalopathy (disease of the brain), characterized by symptoms of anxiety, delirium with hallucinations, delusions, convulsions, and acute psychosis. In contrast to inorganic lead intoxication, peripheral nerve damage is not observed. The current PEL-TWA for both TEL and TML is 0.075 mg/m^3 as lead.

Polynuclear Aromatic Hydrocarbons (PAHs)

Exposure to polynuclear aromatic hydrocarbons (PAHs) can occur via inhalation of vapors, ingestion, and skin and eye contact. Skin contact can result in reddening or corrosion. Ingestion can cause nausea, vomiting, blood pressure fall, abdominal pain, convulsions, and coma. Damage to the central nervous system can also occur. The U.S. Department of Health and Human Services has classified 15 PAHs compounds as having sufficient evidence for carcinogenicity, while the EPA has classified at least 5 of the identified PAHs as human carcinogens. There are no currently assigned PEL-TWA for PAHs, but the closely related material coal tar is listed as coal tar pitch volatiles with a PEL-TWA of 0.2 mg/m^3.

Antimony

Antimony exposure can occur via inhalation of dust or fume, skin or eye contact. Dusts and fumes are irritants to the eyes, nose and throat, and antimony is considered a primary skin irritant. Symptoms of exposure include a dry throat, nausea, headache, dizziness, and loss of appetite. A severe dermatitis can result from exposure to antimony trioxide. Target organs following exposure to antimony via the lungs are the heart, lungs, and respiratory tract. Liver and kidney damage can also occur following exposure. Severe respiratory irritation can result from inhalation, and circulatory or respiratory collapse can follow, culminating in death. The current PEL-TWA for antimony is 0.5 mg/m^3.

Arsenic

Arsenic is toxic by inhalation and ingestion of dusts and fumes or by inhalation of arsine gas. Trivalent arsenic compounds are the most toxic to humans, with significant corrosive effects on the skin, eyes, and mucous membranes. Dermatitis also frequently occurs, and skin sensitization and contact dermatitis may result from arsenic trioxide or pentoxide. Trivalent arsenic interacts with a number of sulfhydryl proteins and enzymes, altering their normal biological function. Ingestion of arsenic can result in fever, anorexia, cardiac abnormalities, and neurological damage. Liver injury can accompany chronic exposure. Skin and inhalation exposure to arsenic has been associated with cancer in humans, particularly among workers in the arsenical-pesticide industry or copper smelters. The EPA currently classifies arsenic as a Class A, or confirmed, human carcinogen. Arsine is a highly toxic gaseous arsenical, causing nausea, vomiting, and hemolysis. The current PEL-TWA for organic and inorganic forms of arsenic is 0.2 mg/m^3.

Barium

Barium is toxic via ingestion or inhalation of dust or fume, or by skin or eye contact. Barium causes local effects including irritation to the eyes, nose, throat, and skin. Systemic effects include an increase in muscle contractibility, intestinal paralysis, and increased muscle tension and vascular constriction. Inhalation of barium dusts may cause a benign lung inflammation. The current PEL-TWA for barium as soluble compounds is 0.5 mg/m^3. For barium sulfate, the PEL-TWA for total dust is 10 mg/m^3 and for respirable dust is 5 mg/m^3.

Cadmium

Cadmium is toxic via inhalation or ingestion of fumes or dust. Fumes are contacted normally during exposure to heated metals (plating operations, welding, etc.). Acute effects resulting from such exposures include respiratory distress and irritation which may culminate in chronic emphysema. Chronic exposure to fumes or dust may also result in emphysema and kidney damage. These effects may be potentiated by smoking. Cadmium is considered to be a probable human carcinogen, and is currently classified by the EPA as a Class B1, or probable, human carcinogen via the inhalation route. The current PEL-TWA for cadmium is 0.05 mg/m^3 as cadmium dust and salts.

Chromium

Chromium metal and insoluble chromium salts can affect the body if inhaled or swallowed. Ferrochrome alloys have been associated with lung disease in humans. Certain forms of chromium (VI) compounds have been found to cause increased respiratory cancer among workers; EPA classifies chromium (VI) as a Class A, or confirmed, human carcinogen via the inhalation route. Unless it can be demonstrated that no chromium (VI) compounds are present, chromium should be treated as a carcinogen. The PEL-TWA for chromium (III) compounds is 0.5 mg/m^3, and for chromic acids and chromates (chromium VI) the PEL-TWA is 0.1 mg/m^3.

Copper

Copper exposure can occur via inhalation of dust or fume, ingestion, or skin and eye contact. Copper salts can act as skin irritants, causing itching and dermatitis. Eye contact can result in severe damage, including corneal damage. Contact with metallic copper can result in skin thickening, but is not associated with dermatitis in industrial settings. Fumes and dusts can irritate the respiratory tract and result in metal fume fever in severe exposures. Ingestion can result in irritation, but industrial exposure seldom results in damage because copper salts normally induce vomiting. Extensive exposure can damage the lungs, kidneys, skin, and liver. The current PEL-

TWA for copper as dust and mists is 1.0 mg/m^3, while the limit for copper as fume is 0.1 mg/m^3.

Lead

Inorganic Lead. Inorganic lead exposure can occur via inhalation of dusts or metal fumes, ingestion of dusts, and skin and eye contact. The principal target organs of lead toxicity include the nervous system, kidneys, blood, gastrointestinal, and reproductive systems. Generalized symptoms of lead exposure include decreased physical fitness, fatigue, sleep disturbances, headaches, bone and muscle pain, constipation, abdominal pain, and decreased appetite. More severe exposure can result in anemia, severe gastrointestinal disturbance, a "lead-line" on the gums, neurological symptoms, convulsions, and death.

Neurological effects are among the most severe of inorganic lead's toxic effects and vary depending on the age of individual exposed. Effects observed in adults occur primarily in the peripheral nervous system, resulting in nerve destruction and degeneration. Wrist-drop and foot-drop are two characteristic manifestations of this toxicity.

In contrast, the toxic effects of inorganic lead exposure among the young are typically concentrated in the brain. Considerable attention has recently been focused on potential health effects in infants and young children resulting from trace level exposures to lead. Principal symptoms identified in these studies include changes in blood enzymes (particularly in amino levulinic acid dehydrase) and neurological effects. Exposures resulting in blood lead levels in the range of 15 - 50 µg/dL have been reported to be associated with neurological deficits in psychometric intelligence;attention; visual, auditory, and language function; and classroom behavior. Many researchers believe that these health effects occur at such low doses as to be essentially without threshold. However, recent criticisms of these studies have placed this conclusion in question.

The EPA also currently lists inorganic lead as a Group B2 , or probable, human carcinogen via the oral route. This conclusion is based on feeding studies conducted in laboratory animals. The current PEL-TWA for inorganic lead is 0.05 mg/m^3. Occupational exposure to lead is also specifically regulated under WAC 296-62-07521, with an action level established at 0.03 mg/m^3 that triggers monitoring and other requirements.

Organo-Lead Compounds. The most notable organo-lead compounds are tetraethyl (TEL) and tetramethyl lead (TML). These chemicals are colorless liquids which have been used principally as anti-knock compounds in gasoline. When used as such, they are generally mixed with soluble dyes for identification purposes. In the environment, TEL is reported to decompose under sunlight to form crystals of mono-, di-, and triethyl lead compounds, which have a characteristic garlic-like odor.

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Mercury

The health effects of mercury exposure are dependent on the chemical form of mercury involved. Elemental mercury is toxic by inhalation, skin absorption, eye, and skin contact. Symptoms of exposure include coughing, chest pains, headache, fatigue, salivation, weight loss, and skin and eye irritation. The primary target organ of elemental mercury is the central nervous system, resulting in damage to sensory systems. The PEL-TWA for exposure to mercury vapor is 0.05 mg/m^3.

Inorganic mercury compounds are toxic by inhalation, ingestion, and skin and eye contact. Acute poisoning results in lung damage. Chronic poisoning typically produces four classical symptoms: gingivitis, salivation, increased irritability, and muscular tremors. Delirium and other psychological abnormalities can also result from chronic exposures. Inorganic mercurials also have a corrosive effect on the alimentary tract, and kidney damage can result from exposure. The current PEL-C (Ceiling) limit for inorganic mercury is 0.1 mg/m^3.

Organomercury compounds include the methyl mercuries and aryl mercuries, many of which are used as herbicides or pesticides. Methyl mercury is toxic by inhalation, resulting in central nervous system damage manifested in tremors and sensory disturbances. Infants exposed to high methyl mercury before birth can exhibit severe central nervous system damage. The current PEL-TWA for organo-alkyl compounds as Hg is 0.10 mg/m^3 with an STEL of 0.03 mg/m^3, and the PEL-C (Ceiling) for aryl mercury compounds as Hg is 0.1 mg/m^3.

Nickel

Nickel exposure can occur via inhalation of dust or fume, ingestion, and eye and skin contact. Nickel and its compounds are irritating to the eye and mucous membranes, and skin exposure frequently leads to sensitization and a chronic eczema referred to as "nickel itch." Elemental nickel and nickel salts are considered probable carcinogens via inhalation, and nickel carbonyl is clearly recognized as a human carcinogen. Animal studies have demonstrated health effects on the kidneys, liver, brain, and heart muscle. The current PEL-TWA for soluble nickel and insoluble nickel are 0.1 and 1.0 mg/m^3, respectively. The PEL-TWA for nickel carbonyl is 0.007 mg/m^3 as nickel.

Silver

Local effects from metallic silver include implantation of particles into the skin, resulting in permanent discoloration. Silver nitrate is highly corrosive to tissues and may cause severe eye damage. Silver is strongly bioaccumulated and excretion is very low. Chronic exposure to silver dusts can cause lung irritation. Kidney and liver damage can also result from repeated exposure. The current PEL-TWA for silver metal is 0.01 mg/m^3.